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An investigation into student outcomes and experiences following a physiotherapy curriculum redesign

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An Investigation into Student Outcomes and Experiences Following a Physiotherapy Curriculum Redesign

Melanie Lindley

A thesis submitted in partial fulfilment of the requirements of

Sheffield Hallam University

for the degree of Master of Philosophy

January 2022

Declaration

I hereby declare that:

1. I have not been enrolled for another award of the University, or other academic or professional organisation, whilst undertaking my research degree.

2. None of the material contained in the thesis has been used in any other submission for an academic award.

3. I am aware of and understand the University's policy on plagiarism and certify that this thesis is my own work. The use of all published or other sources of material consulted have been properly and fully acknowledged.

4. The work undertaken towards the thesis has been conducted in accordance with the SHU Principles of Integrity in Research and the SHU Research Ethics Policy.

5. The word count of the thesis is 65526 (plus References, Bibliography and Appendices).

Signed:

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Date	*18th January 2022*
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Abstract

Within the cardiovascular-respiratory specialism of Physiotherapy, practice has moved from being situated predominantly in the acute hospital setting to community rehabilitation and long-term management. Occurring at a time when there have been extraordinary developments in new technologies applied to teaching and learning, these seismic changes have created fresh challenges for the delivery of undergraduate Physiotherapy programmes.

Research has shown that the inclusion of technologies alone within curricula does not improve learning; and that pedagogic decisions should drive the choice of technology. It has also been shown that appropriately selected learning technologies can improve student engagement and experience. However, few studies have investigated the impact of a range of learning technologies on both learning outcome and student experience so there are some important knowledge gaps in this connection.

The study investigated the impact of a range of teaching approaches, including bespoke video-based and online resources, in an undergraduate cardiovascular-respiratory Physiotherapy module over two consecutive academic years. A mixed -methods, crossover study design study was developed to examine student learning outcomes, learning experiences and perceptions of clinical ability. A novel visual thematic analysis method applied to focus groups was developed.

This study showed that the module redesign and the inclusion of range of learning technologies led to improvements in student knowledge, understanding and clinical reasoning, when compared to the other specialism modules; self-assessment scores did not show any relationship with assessed measures, suggesting the need for greater use of facilitated debrief and reflection on and in-action; the redesign and the inclusion of learning technologies impacted positively on the student experience, with variety being identified as an important factor; and visual resources and simulation were seen by students as having the greatest potential to aid application of learning to clinical practice. Implications of the findings are considered for learning and teaching approaches that could better develop clinical reasoning, as well as for future work in assessment and self-assessment of clinical ability. Directions for future research are suggested.

Table of Contents

List of Tables

List of Figures

List of Appendices

Abbreviations

AR	Augmented Reality
CPD	Continuing Professional Development
CSP	Chartered Society of Physiotherapy
CSR	Comprehensive Spending Review
CVR	Cardiovascular-Respiratory
DC	Digital Capability
GDPR	General Data Protection Regulation
Gen X	Generation X
Gen Z	Generation Z
HCPC	Health and Care Professions Council
HDU	High Dependency Unit
HE	Higher Education
HEA	Higher Education Academy
HEE	Health Education England
HEI	Higher Education Institute
ICF	International Classification of Functioning, Disability and Health
ICT	Information and Communications Technology
IPE	Inter-professional Education
JISC	Joint Information Systems Council
L&T	Learning and Teaching
LTA	Learning, Teaching and Assessment
MCQs	Multiple Choice Questions
MM	Mixed Methods
MSK	Musculoskeletal
NEURO	Neurological
NIV	Non-Invasive Ventilation
NSS	National Student Survey
ONS	Office for National Statistics
PRP	Principles and Practice of (Cardiovascular) Respiratory Physiotherapy
PSRB	Professional, Statutory, Regulatory Bodies

PG	Post-Graduate
PICU	Paediatric Intensive Care Unit
QAA	Quality Assurance Agency
RCT	Randomised Controlled Trial
SCT	Social Cognitive Theory
SEC	Socio-economic Class
SETs	Standards of Educational Training
SoPs	Standards of Proficiency
TEF	Teaching Excellence Framework
TEL	Technology-Enhanced Learning
UG	Undergraduate
VLE	Virtual Learning Environment
VR	Virtual Reality
WCPT	World Confederation of Physical Therapy
WHO	World Health Organisation

Dedication

To Richard, you are the first person in my life who made me realise I could "shoot for the moon". Thank you for encouraging me to dare to try.

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A huge thank you goes to my academic supervisors, Dr Neil McKay and Professor Gordon Grant. You helped me navigate this journey from its inception. I have learned so much more than the contents of this thesis.

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Preface

This study arose following the redesign of the cardiovascular-respiratory module within an undergraduate physiotherapy programme. The redesign was in response to feedback from students indicating that the module overwhelmed them with theoretical content that they struggled to grasp, and which provided limited application to clinical practice. Chapter 1 provides the background to the core theme of this thesis: how the current socio-political climate influences the profession of physiotherapy; and how that in turn influences physiotherapy education.

The module redesign employed a co-design model defined as a highly facilitated team-based process in which teachers and students work together to design an educational innovation (Roschelle, Penuel, & Shechtman, 2006). In light of this approach, the student learning experience is the third core theme that runs throughout this thesis.

Students worked within the module descriptor framework to review current teaching content and identify areas that were particularly problematic. Students then suggested alternate L&T approaches and types of resources. The majority of which involved the use of media or technology in some way. Details of the module in which this study is based, the underpinning pedagogy and the redesign are provided in Chapter 2.

Concurrent to the review and redesign was a literature review of the proposed L&T approaches to be utilised in the module. At the time there was a paucity of literature pertaining to the impact of the types of learning technologies and approaches within healthcare education. The literature review prior to the start of the study can be found in Chapter 3.

Key to the principle of co-design is the process of evaluation. The driving force of the redesign was to improve the knowledge, understanding and clinical reasoning of students, and to significantly improve the learning experience. The culmination of wanting to know if the revised pedagogy and technologies addressed the issues of a quality learning experience, improved knowledge and understanding, as well as the development of clinical reasoning shaped the methodological choices for the study. These are presented in Chapter 4.

The results are presented in Chapter 5, followed by a 'bridging' literature review in Chapter 6. This second literature review was deemed necessary due to the advances in both the learning technologies used within Higher Education and the evidence base for their employment, concurrent with the duration of the study. Chapter 6 situates the results of this study relative to current thinking to enable the discussion, Chapter 7, to consider the implications of the findings relative to current thinking, identifying the original contribution this study makes.

CHAPTER ONE: BACKGROUND

This study investigates the outcomes of redesigning an undergraduate cardiovascular-respiratory Physiotherapy module on the development of knowledge, clinical reasoning and the overall student learning experience. Core to this thesis are three main threads that run throughout: clinical reasoning within physiotherapy practice; physiotherapy educational approaches, including the utilisation of learning technologies; and the student learning experience.

This chapter sets the scene in how physiotherapy practice and physiotherapy education have evolved relative to changes in the respective healthcare and education sectors, as well as within society. It is in response to these changes, as well as feedback from students, that acted as the catalyst for the module redesign that resulted in this study. This study sets out to: assess the outcome of module redesign on student knowledge, understanding and clinical reasoning; explore the impact on student self-assessment of clinical ability; and gain insights into learning experience as a result of the module redesign.

1.1 The Evolution of Physiotherapy and Healthcare in the UK

1.1.1 The Foundations of Physiotherapy

The origins of Physiotherapy can be traced back as early as 100BC where interventions such as massage, exercise, hydrotherapy and rest were documented (Barclay, 1994; Higgs, 2009). However, the beginnings of modern-day Physiotherapy arguably have two key origins: Swedish Gymnastics and Massage Therapy (Barclay, 1994; Porter, 2013). Swedish Gymnastics was defined in 1813 by Ling; its fundamental principles being physical activity, an understanding of anatomy, physiological principles and education (Barclay, 1994). Ling founded the Central Gymnastic Institute in 1822 providing formal training to students thereafter. Massage therapy developed throughout the 1800s both within society and medicine; in line with emerging medical interventions and the popularity of spas and the associated health benefits of bathing. As a result, massage therapy began to evolve to include hydrotherapy and electrotherapy (Barclay 1994). Training of a masseuse took 2 years; with tuition predominantly provided by physicians and senior masseuses within hospitals, schools or even the masseuse's home. Nurses often received training in massage, with those performing massage in hospitals being known as Nurse-Masseuses (Barclay, 1994). It was three of these early Nurse-Masseuses: Paget, Robinson and Manley that are credited with forming the Society of Trained Masseuses in 1894.

It is clear that these two nascent professions, Swedish Gymnastics and Massage Therapy, had very different origins: Swedish Gymnastics was based in education and exercise; the role of the masseuse in healthcare. However, these roles began to expand and overlap after the first world war, which resulted in the formation of the Chartered Society of Massage and Medical Gymnastics in 1919. This in turn evolved into the Chartered Society of Physiotherapy in 1934, which remains the UK's professional Physiotherapy body to this day (Barclay, 1994).

The fundamental principles of these two original professions can arguably still be identified within current definitions of physiotherapy practice: Physiotherapists help people affected by injury, illness or disability through movement and exercise, manual therapy, education and advice Chartered Society of Physiotherapy (CSP), 2008). Underpinning such definitions of the profession is the premise of optimising quality of life and movement potential, with the paradigms of promotion, prevention, treatment, intervention and rehabilitation forming the foundations of Physiotherapy practice (Physical Therapy, World Confederation (WCPT), 2011).

Since 2003 Physiotherapy and Physical Therapy have been protected titles in the UK and as such are governed by recognised professional and regulatory bodies. In order to practise as a Physiotherapist/Physical Therapist completion of an accredited course, as certified by the country's Regulatory and Professional Bodies, is therefore required. Within the UK, Physiotherapists are regulated by the Health and Care Professions Council (HCPC) which stipulates a range of profession-specific Standards of Proficiency (SoPs) and the requirement for ongoing professional competence (Health and Care Professions Council (HCPC), 2013). These SoPs specify detail as to the nature and expected level required of an individual to practise clinically as a Registered Physiotherapist. The standards are wide ranging; however, and possibly not surprisingly, there is a clear requirement for the application of underpinning knowledge in the assessment, problem identification and management of the patient, client and/or service users in the clinical setting.

It is clear the profession has evolved considerably since its inception during the 1800's, whilst remaining true to the principles of exercise, education and healthcare. This evolution is arguably as a result of government priorities, technological advances and health and social care needs of society as a whole (Kell & Owen, 2008). Whilst the Standards of Proficiency required by the HCPC clearly articulate what skills, knowledge and qualities are needed to practise as a Physiotherapist, how and indeed in what contexts Physiotherapists practise has changed considerably.

1.1.2 Developments in Healthcare Service Provision

In 2000 the Government launched The NHS Plan: a plan for investment, a plan for reform (Department of Health, 2000). This signalled a radical shift in how health services were commissioned (Ham and Murray, 2018). It made a commitment of huge financial investment, coupled with an introduction of closer relationships with private-sector providers and an internal competitive market (Department of Health, 2000). The focus was on increased productivity and reduced waiting times. The plan promised to increase staffing and physical capacity considerably, with 100 new hospitals, 20,000 new nurses and 6,500 additional therapists amongst the pledge. Clinical governance and regulation were key, as too was better clinical outcomes. The drive for clinical excellence paved the way for Physiotherapists to highlight their role in delivering these improved outcomes and strengthen their profile as a core profession, advancing their clinical specialism and extending the scope of recognised skills (CSP, 2008). Thus, paving the way for changes in Physiotherapy education to prepare undergraduates for a more divers professional career.

However, it was the change to funding as well as a renewed focus on public health that arguably started a shift in what, where and how services were provided (Darzi, 2018; Department of Health, 2000). Commissioning decisions were moved away from Health Authorities to Primary Care Trusts (PCTs), with a greater focus on delivering services within primary care settings. Whilst Physiotherapists working in the community was already established practice, the extent to which community-based services began to require Physiotherapy and rehabilitation services, provided an opportunity for the profession to proliferate in this setting.

In 2008 the NHS Next Stage review (Secretary of State for Health, 2008) positioned patients at the heart of the decision-making process surrounding their care and strengthened the need to provide more preventative health measures from education and advice to healthy lifestyles and the promotion of activity. As the origins of Physiotherapy are steeped in education and exercise, this area of healthcare is arguably a natural fit for the profession. It was also during this decade that the implications of an ageing population became apparent (Oliver, Foot and Humphries, 2014). An ageing population brings with it not only an increase in the amount of ill health, but an increase in age-related conditions and long-term co-morbidities (British Medical Association (BMA), 2016). It is estimated that management of the population's long-term conditions currently demands 70% of the total NHS budget (Oliver, Foot and Humphries, 2014). At present in the UK ~18% of the population is over 65, with that set to rise to over 25% in 2050 (Storey, 2018). This predicted increase in the proportion of the aged population therefore places further demands on health and social care services both in terms of delivery and budget (Government Office for Science, 2016) requiring service providers to consider cost-effective ways of delivering health and social care needs as well as means to maintain the health and active lifestyles of the population. These cost-effective, preventative and rehabilitation priorities have enabled Physiotherapists to use this as a vehicle to diversify into these areas of health and social care, moving from a remedial profession to one who's identity has evolved to represent the needs of the communities in which they work (Hammond, Cross, & Moore, 2016).

At the start of 2010, the UK had a change of Government that produced two key papers within their first year: Equity and excellence: Liberating the NHS (Department of Health, 2010a) and Healthy Lives and Healthy People: our strategy for public health in England (Department of Health, 2010b) . Both these papers articulated an intent to improve public health, reduce health inequalities and increase patient choice; as well as improve outcomes and deliver efficiencies. This changing face of health and social care services has had a knock-on effect on Higher Education and the healthcare education programmes they deliver. In order to equip graduates for the working world, HEIs redesigned their curricula to represent both the health and social care needs of the population and the role diversification that has emerged as a result of changing government priorities and the evolution of service provision (Fry, Ketteridge, & Marshall, 2009). With curriculum redesign comes the opportunity to consider the most effective learning and teaching (L&T) approaches that meets both the SoP required by the professional body to be deemed a safe and effective practitioner, and the students' learning needs (Zimmer & Keiper, 2020).

In 2014, the Government's Five-Year Forward View increased further its emphasis on the importance of prevention, as well as targeted intervention (Ham and Murray, 2015). Developing the NHS workforce, and increasing the utilisation of technology in the advancements of healthcare services was also explicitly outlined in this paper. Subsequently, the NHS Long Term Plan (Alderwick and Dixon, 2019) set out seven specific clinical priorities chosen for their impact on the patient's health, where outcomes are lower than in comparable healthcare systems in developed countries. Two of these seven priorities are cardiovascular disease, and respiratory care; which are pertinent to the context of this study. Underpinning much of the targets in these priority areas is the use of technology. In addition to the Long Term Plan, the Topol report (Topol, 2019) articulated the fundamental and increasing role technology will have in healthcare provision in the assessment, diagnosis, monitoring and rehabilitation of patients over the next 5-10 years. These changes to how we utilise technology to support, enhance and in some instances, potentially, replace services, will no doubt have an impact on the design of future physiotherapy curricula.

The ageing population, their associated health and social care needs and the shift towards the primary care setting, prevention and self-management have required healthcare professionals to adapt and evolve. This includes not only the services provided but the way in which we as a profession practise. Physiotherapy has historically aligned itself to medical philosophies and approaches (Nicholls, 2018). However, meeting the complex health and social care needs of the population requires a holistic and embodied approach more and more (Adler & Malone, 2012). Physiotherapy has therefore evolved considerably over the last decade in terms of what, where and how we practise.

1.1.3 The Response of The Profession to the Changing Healthcare Landscape

Musculoskeletal, neurological and cardiovascular-respiratory have been long-standing core specialisms within Physiotherapy (CSP, 2008); however, the underpinning physiotherapy principles of rehabilitation, enablement, activity, education and self-management have meant that physiotherapy services are now also routinely commissioned within areas such as learning disabilities, mental health, paediatrics, public health and women's health (CSP, 2008). This diversification into wider services, alongside the increased prevalence of co-morbidities seen in patients requiring physiotherapy, have presented an interesting juxtaposition for the advancement of the profession. The increasing complexity of patients presenting for physiotherapy has necessitated the identification and development of specialist and extended scope physiotherapy skills (CSP, 2016). Increasingly, practising Physiotherapists are also required to draw on a broad knowledge base and to be familiar with principles and practice spanning multiple 'core' specialisms in order to provide tailored, holistic management and/or intervention for those presenting with a range of co-morbidities.

Key to the ability to provide effective therapeutic intervention is assessment, examination, evaluation, diagnosis, treatment planning and implementation (Higgs et al 2008; Edwards et al, 2004); the culmination of which is known as clinical reasoning. It is the development of skills required for effective clinical reasoning that are fundamental to this thesis; and indeed, the physiotherapy profession (Vaughan-Graham & Cott, 2017). The term Clinical Reasoning is often used to describe the process of requiring a background of scientific and technological research-based knowledge and a practical ability to discern the relevance of the knowledge; applying it to a particular clinical situation, forming clinical decisions and/or conclusions (Benner, Hughes, & Sutphen, 2008).

The origins of clinical reasoning stem from medicine and the need for accurate diagnosis in order to formulate a treatment plan (Marcum, 2012; Cooper and Frain, 2017). As Physiotherapy emerged as a profession allied to medicine, it is therefore not surprising that its early model of clinical reasoning mirrored that of the medical model. Namely: observation, examination and analysis, in line with standardised tests and procedures. Historically, the focus on clinical reasoning was hypothetico-deductive reasoning whereby rule-based premises were to be applied, but with additional testing of hypotheses to enable the ruling in or out of possible diagnoses (Cooper and Frain, 2017). Some of the criticisms levelled at hypothetico-deductive reasoning, however, are in relation to the premise being very much the 'what' and not the 'how' or 'why' (Jupp, 2006). So, whilst this model of clinical reasoning facilitates the culmination of an accurate diagnosis, it may not truly represent the wider factors impacting on the health and wellbeing of an individual. As an approach within Physiotherapy it therefore does not facilitate a truly holistic approach to patient assessment and management.

Greater awareness of the importance of the psychosocial elements within the biopsychosocial model over the last 20 years has caused a gradual shift away from biological and physiological changes being the predominant focus of clinical reasoning within physiotherapy, with a move towards general principles and strategies underpinning the process (Higgs, Richardson and Dahlgren, 2004). Furthermore, in 2001, the World Health Organisation (WHO) gained the endorsement of 191 member states for their International Classification of Functioning, Disability and Health, (ICF) (World Health Organization, 2002). This framework enabled the classification of individuals and populations and considered wider factors such as the environment and personal influences. It also placed equal focus on three main domains of a disease or disorder: Body Functions and Structures; Activity; and Participation. This placed greater emphasis on a more holistic approach to the assessment of an individual. Clinicians are now expected to consider not just physiological and physical impairments, but how they impact on the ability of an individual to be active, and how they are able to participate in wider society. In addition, there is an expectation that environment factors and individual perspectives are appropriately recognised.

One of the ongoing challenges, however, is the lack of shared understanding of the term Clinical Reasoning between healthcare professionals (Huhn et al, 2019). This is not necessarily surprising, as the way in which different professions work may necessitate very different approaches. Despite the lack of consensus, Physiotherapy as a profession has evolved its approach to clinical reasoning (Elvén and Dean, 2017) embodying a much more inclusive, shared decision-making approach where patients are jointly involved and have choice over their care (Edwards and Jones, 2007). This approach is further reinforced by the government policies and drivers placing patients and service users at the heart of decision-making. The approach to clinical reasoning taken within the module in which this study is situated is explored in more detail in section 2.2.2.

Whilst there has been a wholesale change in the way Physiotherapists approach clinical reasoning, the extent to which the domains of the ICF are fully applied may vary relative to the context within which they are practising. Whilst the underpinning strategies outlined by Higgs, Richardson and Dahlgren (2004) are likely to be evident across all specialisms, the nature of work may necessitate focus in different domains of the ICF, or indeed different approaches to communication, negotiation and joint goal setting. For example, a patient presenting with long term neurological rehabilitation requirements at home may be assessed with greater emphasis on the activity and participation domains within the ICF; however, an acutely unwell, deteriorating patient within the Intensive Care Unit may be assessed with greater focus on the body functions and structures domain. The literature surrounding Clinical Reasoning in Physiotherapy, how it has evolved and indeed how clinical reasoning skills are taught and developed within undergraduate education programmes are explored in more detail within Chapter 3: Literature Review.

1.1.4 The Role of Technology in Healthcare and its Implications for Physiotherapy Practice

Technological advancements in healthcare have been evident since the electro-cardiograph (ECG) was invented in 1895 (AlGhatrif and Lindsay, 2012). However, the pace of developments has increased substantially in the last 20 years alongside societal advances in technology. Digital Health has been used to describe the convergence of a range of technologies, spanning a range of functions and purpose. Whilst there has been no agreed classification of these technologies, possibly in part due to their emergent status, these can be broadly classified by their functionality: system service; inform; simple monitoring; communicate; preventative behaviours change; self-manage; treat; active monitoring (National Institute for Health and Care Excellence, 2019). These classifications encompass a wide range of technologies and purposes. For example, e-health, the systems and services that store and retrieve clinical data; healthcare technology, used to assess, diagnose and monitor; telehealth, technologies that enable remote access and interactions between patient and clinicians; assistive technologies to aid rehabilitation and activity; and simulation, to support staff development and improve patient outcomes. In addition to these there is the advent of Smart device/Mobile Apps, Artificial Intelligence, Virtual Reality and Gamification (Ma & Zheng, 2011). All of these digital healthcare advancements have the potential to impact on how Physiotherapists assess, treat and communicate with our patients.

The Topol report: Preparing The Healthcare Workforce To Deliver The Digital Future (Topol, 2019) identified 10 top technologies as having the greatest impact on the healthcare workforce. These 10 technologies have been broadly categorised under one of three headings: Digital Medicine, Genomics and AI & Robotics:

- Telemedicine (Digital Medicine)
- Smartphone apps (Digital Medicine)
- Sensors and wearables for diagnostics and remote monitoring (Digital Medicine)
- Reading the genome (Genomics)
- Speech recognition and natural language processing (AI &Robotics)
- Virtual and augmented reality (Digital Medicine)
- Automated image interpretation using AI (AI &Robotics)
- Interventional and rehabilitative robotics (AI &Robotics)
- Predictive analytics using AI (AI &Robotics)
- Writing the genome (Genomics)

The expectation of this report is that within the next 20 years the NHS workforce will access workforce, anatomical and physiological information, as well as social, behavioural and environmental data to deliver a more holistic approach to healthcare and disease prevention (Topol, 2019). With this comes an expectation that, in order to deploy this level of digital healthcare, patients will need to be included as partners and fully informed about these technologies; the workforce needs expertise and guidance to evaluate these technologies and there needs to be opportunities to develop and utilise newer technologies. The challenge, however, will be delivering this ambition within the budgetary constraints of the NHS.

In 2019 a Digital Framework for AHPs AHPs (England, NHS, 2019) set out 3 key ambitions for the AHP workforce within health and social care. These ambitions are: Digitally ready AHP services, which relates to the strategic intent and alignment of services, plus the digital literacies of the workforce; Digitally mature AHP services which pertains to the effective integration and utilisation of technologies; and Data enabled AHP services which aim to use technologies to improve the safety, quality and outcomes of AHP services. Certainly, many of the Digital Medicine and AI & Robotics identified within the Topol report are likely to be encountered by Physiotherapists so it is essential to equip the workforce with the necessary digital literacies to perform competently in a digital working world.

Whilst the Topol report (2019) and the Digital Framework for AHPs (England, NHS, 2019) were published subsequent to this study, they serve to highlight the increasing importance and prevalence of technology across healthcare. Increasingly technologies are being utilised within Physiotherapy settings to support rehabilitation, provide education, and bring about behaviour change (Ma & Zheng, 2011) Physiotherapy education programmes therefore need to ensure strong links with clinical practice in order to develop the content within curricula to reflect the emerging service priorities and technological developments.

1.1.5 Using Cardiovascular-Respiratory Physiotherapy as an Illustration of How Specialisms Have Evolved

Cardiovascular-respiratory (CVR) Physiotherapy is an established specialism in its own right (Pryor and Prasad, 2008; Hough, 2013) and hence was incorporated within the undergraduate Physiotherapy curriculum in which this study is situated. CVR physiotherapy aims to enhance gaseous exchange, enable effective removal of sputum and improve exercise capacity (Pryor and Prasad, 2008). Historically, CVR physiotherapists predominantly worked in the medically acute, surgical and intensive care secondary care settings (CSP, 2008), regularly assessing and treating those patients with conditions such as Cystic Fibrosis and COPD acute exacerbation. In addition, CVR Physiotherapists routinely provide services to patients following major abdominal, cardiac or thoracic surgery and to those patients ventilated on ICU needing assistance in clearing secretions (Main and Deheny, 2016). Much of the role of a CVR Physiotherapist on the surgical ward environment is the prevention and treatment of post-operative pulmonary complications and early mobilisation to expedite recovery and discharge (Main and Deheny, 2016). CVR physiotherapy also provides emergency on call service provisions for those patients with acutely deteriorating respiratory function (CSP, 2008).

Initially cardiac rehabilitation services were developed for those patients following myocardial infarction and/or coronary artery bypass surgery and were often based within the hospital setting (Lear & Ignaszewski, 2001). Additionally, pulmonary rehabilitation programmes emerged to improve the exercise capacity and wellbeing of those patients with COPD and/or chronic respiratory conditions (American Association of Cardiovascular & Pulmonary Rehabilitation, 2011). Again, these were initially hospital-based programmes (Goldstein and Marciniuk, 2011). Early rehabilitation of the intensive care patient gained traction in the mid-late 2000's (Adler and Malone, 2012). However, it was not until the impact of the NHS plan (2000) was realised and the subsequent Darzi report (2008) that there was a noticeable shift towards the primary care setting for CVR Physiotherapy (Denehy, Granger, El-Ansary, Parry, 2018).

The shift towards the delivery of more services within primary care, coupled with the changing health needs of society has seen an increase in community based CVR Physiotherapy services. Such service provision can now be observed across a range of long-term conditions, such as COPD, ventilatory support in the home for those patients with neuromuscular insufficiency and community-based exercise programmes (England, 2013; Cambach, Chadwick-Straver, Wagenaar, van Keimpema, & Kemper, 1997). In addition, increasingly there is the use of web-based platforms to enable CVR Physiotherapists to review patients in their home rather than asking them to attend clinic appointments (Houchen-Wolloff et al., 2018). This is in addition to the proliferation of apps to support the management of a range of conditions and encourage healthy active lifestyles. Many of the principles underpinning these services and software applications include health promotion, education, self-management and enablement, aligning to the activity and participation domains of the ICF.

At the time of study commencement, early rehabilitation of the ICU patient was emerging as a priority development within CVR Physiotherapy, but the implementation of widespread community based CVR Physiotherapy services was not fully realised across healthcare services. In addition, the use of healthcare apps for self-management and tele-health technologies to support digital assessment and monitoring of patients were not commonplace, although the use of online tools and information for patients and carers was. Also apparent at the time was the prevalence of co-morbidities within the population of patients requiring physiotherapy. Increasingly, physiotherapists were addressing CVR compromise within non-CVR settings: for example, rehabilitation of patients following orthopaedic surgery, and patients within the community setting with neurological impairment. The prevalence of co-morbidities in particular, both in terms of non-CVR morbidities impacting on the approach taken in CVR physiotherapy and the presence of CVR co-morbidities on other impairments, highlights the importance of ensuring physiotherapists have the necessary knowledge and skills across the range of core specialisms, regardless of the setting in which they work. The predominant focus and content of the CVR module in relation to the work settings student would likely encounter CVR patients is discussed in section 2.2.

1.2 Developments in Higher Education

1.2.1 The Student Learning Experience

One of the key commitments across the Higher Education (HE) sector is the delivery of excellence in learning and teaching (Gunn and Fisk, 2013). However, the drive to achieve this is far from altruistic. As the HE sector has become increasingly competitive over the last decade (Marginson, 2004), the need to demonstrate the quality of learning and teaching (L&T) to prospective students has gained greater strategic and financial importance. Whilst the term 'quality' is widely used, the means by which to most accurately measure it in the context of L&T still lacks consensus (Arjomandi, Kestell and Grimshaw, 2009; Gibbs, 2010). Debate therefore surrounds the definition of quality, the dimensions that underpin and affect it, and the deliverables that can be used to measure and quantify it (Gibbs, 2010; Harvey and Green, 1993; Welzant et al, 2015). It is also widely acknowledged that perceptions of quality in HE continually evolve, influenced additionally by educational, societal and economic factors (Ewell, 2010; Harvey, 2007; Harvey & Williams, 2010; Welzant et al, 2015). Perceptions are also extremely subjective and will vary significantly based on each person's values and prior experiences (Bennett and Kane, 2014; Gibbs, 2010).

Despite these variables, the link between educational quality and student experience has been assumed, for the last 15 years, by the National Student Survey (NSS). The NSS canvasses final year undergraduate students about their experiences of their course, encompassing their experiences of teaching and assessment to their overall satisfaction. The results are used to rank Universities in the UK, providing an indication of perceived quality. Irrespective of the NSS's universal application, it has come under criticism for not accurately reflecting how engaged students feel or for failing to represent the actual quality of the learning and teaching delivered (Gibbs, 2010; Bennett and Kane, 2014).

One of the biggest reported factors in student satisfaction is the amount and quality of time spent with academic staff. High staff to student ratios are costly for organisations and therefore any direct student contact needs to produce value for money for the organisation, whilst also being a meaningful experience for students. HEIs are therefore looking at ways to optimise the time academics spend with students to maximise the learning opportunity that arises from direct contact time with academics; and further improve the student experience. This is of significant importance when considering the role of technology and the increasing move towards online learning as a means of facilitating learning before students enter the classroom and optimising the time they have with the tutor. The ration of staff to students is also a consideration when facilitating practical/clinical skills; and is discussed in section 5.5.2.

The pace of technological change has accelerated over the last 20 years (Kurzweil, 2014) with the majority of the UK population using mobile and smart technologies throughout their daily lives (Serafino, 2019). How we as a society interact with technology, how technology can and is being harnessed to improve healthcare, and indeed the role of higher education in equipping graduates to live and work in a digital world are all factors that influence undergraduate education programmes.

1.2.2 The Role of Digital in Higher Education

Web 2.0 started to emerge as a phenomenon at the turn of the century (Toledano, 2013), signalling a sea-change in the way content on the world wide web was being designed and utilised. Ultimately one of the biggest changes that emerged was the shift from hardware to software within the technology industry (Andreessen, 2011), and with it the speed of evolution. It hailed the transition from static content to a more dynamic, organized Web, based on serving applications to users (Andreessen, 2011). Web 2.0 enabled people to collaborate en masse and share information online for the first time, developing communities of users. It is these communities and interactions that have revolutionised society as a whole and the way in which those who engage with technology live their lives. The resulting impact has been not only the connectivity, but the immediacy and ease of access to information. This has necessitated a digital transformation in HE to reflect these societal changes (Brown et al., 2020)

Social media is one element that emerged from Web 2.0 and is described as websites and applications that facilitate online communities and communication (Hollinderbäumer et al, 2013). The technology involved is said to enable users to create and share content and/or to participate in social networking. Social media technologies range from blogs, social networks, forums, sharing of resources and media (e.g. articles, documents, videos, photos) to virtual worlds and gaming (Aichner and Jacob, 2015). Platforms that support these functions include: Facebook, YouTube, Twitter, Reddit, Pinterest, Google+, LinkedIn, ResearchGate to name but a few. In recent years the term social media has become synonymous with particular platforms (Facebook, Twitter); however, it is important to realise that this term relates to their functionality, not to the specific platforms themselves.

For those individuals born after the mid-1990s, Web 2.0 is all they have experienced. Many have used the internet from a young age, utilising technologies effortlessly across their personal and social lives (Eynon and Malmberg, 2011; Blank and Groselji, 2014). These individuals have been categorised as Generation Z (Heery and Noon, 2017). Emerging findings from early population studies of Generation Z seem to identify these as individuals who, for the most part, value and favour the ability to interchange seamlessly between online means of accessing information, communicating and interacting with one another (Mintel Group, 2018). Seventy-five per cent of all undergraduates in Higher Education are now under 25 and studying full-time (HESA, 2018). It is important, therefore, to appreciate the ways in which this, or indeed any generation of learners, engages with technology personally and socially. It is also prudent to consider how these practices may influence an individual's engagement with, or approach to, learning; whilst not assuming that a personal/social digital fluency equates to a L&T one.

Triangulating the impact of society's dependence on technology, the behaviours and expectations of those using it, with the aforementioned drivers both within HE and healthcare, adds an additional dimension to the narrative within this study. Students at university expect seamless access to technology (JISC, 2015). However, despite the desire for the experience to be seamless when accessing technologies, students do not necessarily want more; and not at the perceived expense of quality face-to-face contact time. It is the balance between the need to reflect technology's place within contemporary society with a quality learning experience that influenced the aims and methodological choices of this study. Investigating the student experience in light of the learning technologies used following the module redesign (outlined in section 2.3.4 and 2.3.5), as well as the impact on learning outcome was an important aspect of this study.

At the time of writing, most education-based polls of Generation Z indicate a preference towards active and independent and peer-learning approaches, with a focus on learning through doing, rather than being consumers of knowledge imparted to them (Seemiller and Grace, 2016). However, there seems to be some disagreement between academics as to the value of peer learning in developing knowledge and understanding (Stigmar, 2016). Appropriate feedback from academic staff is likely to be a significant factor in these situations, both in terms of facilitating learning and increasing the confidence of students in the quality of the resources generated by their peers. By using collaborative online tools to collate, curate and create collective content, students have the potential to significantly increase access to resources specifically created for their learning context.

Scepticism exists in some spheres about the quality of independent learning by this group of students. Concerns include a preponderance towards technology with a focus on speed of access (Nicholas, 2008), the skills required to search for and obtain appropriately robust resources to support learning (Purcell et al, 2012) and the ability to discern the relative quality of resources; including differentiating between opinion and empirical evidence (Beetham and White, 2013). These concerns were recognised by JISC (2015) who articulated development needs of students in the arena of information. Students entering Higher Education were seen as relative novices in their chosen field; with a plethora of possible sources of information available online to support their learning journey. JISC stipulated in their Digital Capability Framework (JISC, 2015) that students need support and guidance on how and where to access appropriate information and resources, as well as the skills to discern the quality of the information they are accessing.

JISC also articulated the need for HEI's to support the development of students' digital literacies and capabilities to enable each to live, learn and work in a digital society. Six key areas were identified: information, data and media literacies; digital creation, problem solving and innovation; digital communication, collaboration and participation; digital learning and development; digital identity and wellbeing and general ICT proficiency. Data and media literacies, digital identity and wellbeing are important early steps in the digital literacy journey that too often can be overlooked (Burton, Summers, Lawrence, Noble, & Gibbings, 2015). It is reasonable to assume that current technologies will continue to evolve, and some will be superseded. Whilst there may exist an assumption than Gen Z habitually seek out new ways of working and continually adapt, it is possible that they are merely familiar with a far larger range of technologies than Gen X and the millennials.

In an era of ever-increasing changes to technologies, HEI programmes may need to focus on engendering agility, resilience and problem-solving skills rather than specific digital/ICT literacies. This is equally true for healthcare education courses where the evolution of digital health technologies will also likely evolve and impact on the ways in which healthcare services are delivered. Furthermore, the increased utilisation of health technologies means graduate physiotherapists will not only need the skills and agility to adapt to evolving healthcare technologies, but also the skills to be able to teach service users how to engage with them as part of their rehabilitation. A skill that may well need incorporating into Physiotherapy education programmes if not already present.

1.2.3 The Response of Undergraduate Physiotherapy Education to the Changing Higher Education Landscape

Embedding technologies within professional training programmes to enhance the learning experience in seen as a priority in HE as indicated by the Higher Education Academy (HEA); Learning 2.0 Harnessing Technology to Enhance Education (Conole, and Alevizou, 2010); Joint Information Systems Committee (JISC); Effective Practice in a Digital Age (JISC, 2009) and the Department of Health (DH); Technology Enhanced Learning Framework (Department of Health, 2011). This provides a clear expectation that technology should be appropriately integrated within HE healthcare programmes to optimise student learning and create a demonstrable impact on professional practice.

1.2.3.1 Developments in Teaching in Physiotherapy Education

Over the last 20 years, physiotherapy education programmes have responded to the evolving landscape to design and deliver more contemporary programmes reflective of the health and social care landscape (Barradell, 2017). As a result, they have become much less didactic in their approach to teaching, opting for more active and dynamic methods (Barradell, 2017). The range of teaching approaches employed within this study can be found in Section 2.3. The teaching of Physiotherapy has also shifted away from repetitive practising of a particular skill, to problem-based learning (PBL) and the use of case studies in conjunction with those practical and clinical skills (Gunn, Hunter and Haas, 2012). Fundamental to PBL is the change towards facilitation, with students learning in small groups (Solomon, 2005) engaging in a discursive problem-solving approach towards a case study or scenario (Solomon, 2005).

To optimise the time spent with tutors who facilitate these discussions, flipped and blended learning approaches have been increasingly embedded within programmes over the last 10 years (Saitta, Morrison, Waldrop, and Bowdon, 2015). Blended and flipped learning incorporates the provision of materials and guided activities for students to undertake in their own time, prior to, during or after the time spent in the classroom (Pettit, McCoy, Kinney, 2017). In addition, the application and transference of learning through a range of scenarios and contexts has increased the utilisation of L&T approaches such as simulation and role play to develop not just clinical skills but communication, teamwork and reflective skills in preparation for practice. Blended learning and simulation feature heavily within this study. Their utilisation within the module in which this study is situated is discussed within section 2.3.4 and 2.3.5.

Simulation is a means by which a mock clinical situation is designed to resemble reality as much as possible (Bearnson and Wiker, 2005; Laschinger et al, 2008; Corrigan and Hardgam, 2011) and where learners can make, detect and correct errors in a safe environment. In the context of healthcare education, this provides the opportunity to practise both clinical and critical thinking skills, without the added pressure of any adverse effects impacting directly on patient care (Bearnson and Wiker, 2005), reflecting both in-action and on-action. The increasingly complex and constantly evolving healthcare services discussed in section 1.1.2 necessitate education programmes to prepare graduates for the complex working world they are likely to encounter (Bleakley, 2010). This has meant equipping students with the ability to apply their physiotherapy skills relative to the context they are in; something that simulation is arguably able to prepare them for. The evidence base surrounding the use of simulation and blended learning approaches is explored in detail Chapter 3 as the impact of these L&T approaches are integral to the module in which this study is situated.

Practice-based learning in the form of clinical placements is a prominent feature within Physiotherapy programmes as it is essential that students apply their theoretical and university-based learning in a clinical environment (HCPC, 2017). Clinical/practice-based placements enable students to develop skills in assessment, problem identification and clinical reasoning skills in the contexts in which they are likely to work. As previously mentioned, clinical reasoning is a complex skill involving the integration of underpinning knowledge, pattern recognition, communication, analysis application of learned skills and behaviours, and reflection. University-based and practice-based learning are therefore inextricably linked, with the university-based learning providing the foundations on which students can apply and enhance their clinical reasoning skills whilst on placement. Within the context of this study, it is the efficacy of university based CVR Physiotherapy teaching as the foundation to CVR clinical practice that is being investigated.

Due to the range of settings in which a CVR physiotherapist may now work, and the increasing complexity of the patients being referred to healthcare services, the likelihood that Physiotherapy students will encounter all situations prior to graduation is extremely slim. Graduates will therefore need to develop the skills to draw on their fundamental CVR knowledge and transfer this to multiple settings and contexts. It is therefore the responsibility of the physiotherapy programme to provide the appropriate learning experiences and facilitate the development of clinical reasoning, communication, reflection and collaborative skills that best enable effective practice in the working world.

1.2.3.2 Developments in Assessment in Physiotherapy Education

Assessments in HE are required to provide an objective, fair and reliable measure of learners' progression and achievement; with the methods used being appropriate to, and effective at, measuring the learning outcomes (QAA, 2018). There seem to be fewer stipulations by the HCPC in relation to the types of assessment required in order to meet the SoPs, when compared to those levied at learning outcomes and indicative content. This provides an opportunity for Physiotherapy education providers to design more innovative and authentic assessment tasks that mirror the evolving nature of the profession; and that also utilise technologies that are representative of the current or future workplace.

In recent years greater awareness of the value of assessment itself on the learning process and the engagement of students has unfolded (Clouder, 2012). As a result, assessment as a means to enable and achieve further learning is now embedded heavily within many healthcare education programmes (Norcini & McKinley, 2007). The relevance and authenticity of assessment has been identified as a key factor in assessment for learning (Sambell, McDowell and Montgomery, 2013). The types of assessment now more readily observed across undergraduate healthcare programmes include presentations and discussion of case studies, group demonstrations (e.g. exercise classes), OSCEs, simulated clinical scenarios, the creation of educational /health promotion materials, conference presentations as well as the more traditional written assessments (Norcini & McKinley, 2007). These assessment tasks better replicate the skills and practices of contemporary health and social care services and draw on the skills required of practicing Physiotherapists. Further discussion of assessment practices within this study are in Section 2.2.6.

1.3 Chapter Summary

This chapter provided an overview of how physiotherapy practise and physiotherapy education have evolved relative to changes in the respective healthcare and higher education sectors, as well as within society. The last 20 years has seen a significant change in the health and social care needs of the UK population, which in turn has necessitated changes to healthcare services. CVR physiotherapy practice has evolved in line with these service developments, which has resulted in changes to the ways and environments in which we practice; as well as the nature of the patients and service users we see with CVR compromise.

Healthcare education has also adapted during this time to become much more dynamic and active in the learning and teaching approaches it employs, placing increased value on authentic, meaningful assessment that acts as a facilitator of learning, not just a measure of it. Additionally, technology now has a significant role in society, healthcare, and education.

In this era of increasing clinical complexity and greater utilisation of technologies across healthcare services, CVR Physiotherapy education is challenged to ensure that the most effective pedagogies and relevant learning technologies to equip graduates with the skills to address the complex needs of their service users in the variety of environments that they may encounter.

Prior to commencing this study, an undergraduate CVR module was redesigned in collaboration with students as a result of their feedback that identified challenges arising from the L&T approaches previously employed. Concern was raised about university-based CVR teaching and its application to clinical practice, thereby limiting the development of CVR clinical reasoning skills.

This study investigates the outcomes of implementing the redesigned undergraduate Cardiovascular-Respiratory Physiotherapy module on the development of knowledge, clinical reasoning and the self-assessment of clinical ability. An important dimension of this study is also evaluating the student learning experience as it was in response to student feedback about their learning experience that initiated the module redesign.

CHAPTER TWO: CONTEXT OF THE STUDY

This chapter provides the context in which the study is situated. Sections 2.1 and 2.2 relate to the curriculum and CVR module prior to the study; the learning, teaching and assessment strategies employed as well as the taught content. Section 2.3 introduces the redesign of the CVR module specifically, including examples of the learning technologies and resources developed, that resulted in this study's commencement.

2.1 Course Overview

The curriculum in which this study is situated is a Full Time 3-year UG Physiotherapy programme at a large post-92 university in the North of England. The focus is the level 5 (year 2) cardiovascular-respiratory (CVR) module. At the time of the study the number of enrolled students on this programme per level of study ranged from 95 to 110. In each year of the programme the cohort was split into sub-groups with class-size ranging from 26 to 32 students per sub-group.

The predominant focus of level 4 (year 1) was foundations in assessment, clinical reasoning, reflection, professional practice and interprofessional working. Tables 2.1, 2.2 and 2.3 provide an overview of each of the taught modules across each of the three levels of study for the programme. There were three Physiotherapy-specific modules at level 4 that introduced the structures and functions of the body as well as the assessment and clinical examination of key body systems/parts. Physiotherapy Skills 1 focused on the cervical spine and upper limb; Physiotherapy Skills 2 the thoracic and lumbar spine and neurology; and Physiotherapy Skills 3 the lower limb, biomechanics and principles of exercise. Transition to Professional Practice addressed core skills such as communication, professional roles and behaviours and reflection. There were also two interprofessional education modules: Introduction to Interprofessional Practice (IIP) and Using Knowledge and Evidence to Support Study and Practice (UKESSP).

Table 2.1 An overview of 1st year taught modules within the Undergraduate Physiotherapy programme (excluding clinical education modules

Level	Module	Aim of module (as written in definitive document)
4	Introduction to Interprofessional Practice (IIP)	To introduce the concept of yourself and your multi-disciplinary colleagues as professionals collaborating with service users and carers in an interprofessional team
4	Using Knowledge and Evidence to Support Study and Practice (UKESSP)	To introduce you to ideas around different types of information, knowledge and evidence that underpins professional practice. It also introduces you to the skills to find, appraise and use evidence that underpins professional practice.
4	Transition to Professional Practice (TPP)	To introduce you to university and professional cultures with a view to underpinning your future studies. To develop team working abilities, presentation skills and evidence and evaluate this in your Professional Development Portfolio (PDP).
4	Clinical Reasoning and Decision Making (CRDM)	To provide you with an underpinning knowledge of the clinical assessment process and to encourage you to link the clinical assessment to clinical decision-making processes and patient centred practice. You will also develop your problem solving and information gathering skills.
4	Physiotherapy Skills 1 (PS1)	To introduce you to the theoretical, anatomical, physiological, biomechanical and biomedical principles which underpin physiotherapeutic theory and practice relating to the Cervical spine and upper quadrant. You will also develop basic physiotherapeutic assessment & treatment skills and demonstrate an understanding of how of key pathologies and dysfunction can affect MSK systems.
4	Physiotherapy Skills 2 (PS2)	To introduce you to theoretical principles, concepts, anatomical, physiological, biomechanical and biomedical principles which underpin physiotherapeutic theory and practice relating to the Thoracic spine and explain how they influence function and movement. You will also develop an understanding of how of key pathologies and dysfunction can affect the neurological and MSK systems.
4	Physiotherapy Skills 3 (PS3)	To introduce you to the theoretical, anatomical, physiological, biomechanical and biomedical principles which underpin physiotherapeutic theory and practice relating to the Lumbar spine and lower quadrant. You will also develop basic physiotherapeutic assessment & treatment skills and demonstrate an understanding of how of key pathologies and dysfunction can affect neurological and MSK systems.

Table 2.2 An overview of the modules delivered during the 2nd year of the Undergraduate Physiotherapy programme

Level	**Module**	**Aim of module (as written in definitive document)**
5	Developing Collaborative Practice (DCP)	To promote your understanding of the importance of effective interprofessional team working, the significance of service user and carer involvement and the policy drivers for collaboration. It will also enable you to reflect on the strengths and weaknesses of these approaches in practice.
5	Using and Evaluating Evidence to Inform Practice (UEEIP)	To build on literature searching skills relevant to health and social care; to facilitate awareness of the importance of interprofessional collaboration in research; and to promote understanding of research designs and their applicability to practice.
5	Principles of Practice in Neurological Physiotherapy (PNP)	To provide you with an introduction to the assessment and treatment of neurological problems. To provide you with opportunities to develop a problem solving and evidence-based approach to neurological physiotherapy.
5	Promoting Wellness through Physiotherapy (PWTP)	Understand current issues in public health and relevant government policy. Understand the role of the physiotherapist in promoting wellness. Apply the principles of exercise to target groups.
5	Rehabilitation of Functional Movement (RFM)	This module aims to help you to develop a sound understanding of exercise theory and practice in order to maximise effectiveness of using exercise within physiotherapy.
5	Principles of Practice in Musculoskeletal Physiotherapy (PMP)	This module will provide you with an introduction to the assessment and treatment of neuromusculoskeletal problems allowing you to develop an evidenced based, problem solving approach to these problems. It will enable you to effectively clinically reason, integrate and apply both specific and generic physiotherapeutic skills which underpin patient centred assessment and management.
5	Principles of Practice in Cardiovascular-respiratory Physiotherapy (PRP)	To provide you with an introduction to the assessment and treatment of cardiorespiratory problems To provide opportunities to develop a problem-solving and evidence-based approach to respiratory physiotherapy in order to enhance your developing clinical practice

Table 2.3 An overview of the modules delivered during the 3rd year of the Undergraduate Physiotherapy programme

Level	Module	Aim of module (as written in definitive document)
6	Capable Collaborative Working (CCW)	To enable you to make the transition from student to capable interprofessional worker, providing a foundation for effective interprofessional collaborative working, lifelong learning and reflective practice.
6	Generating and Evaluating Evidence for Practice (GEEP)	To enable you to build on previous learning and to apply knowledge and skills in utilising, generating and evaluating evidence in your chosen study.
6	Clinical Reasoning and Management (CRM)	To prepare you for clinical practice through the development of your skills in using underpinning evidence, clinical reasoning, evaluation, therapeutic skills and highly developed communication skills in the management of complex case scenarios.
6	Transition to Qualified Practitioner (TQP)	This module will encourage you to explore and apply personal and professional skills and knowledge of organisational concepts to help you develop a critical understanding and appreciation of the skills, requirements, challenges and opportunities relevant to the role transition from undergraduate student to newly qualified autonomous physiotherapy practitioner. This module will support and enhance your preparations for key stages of your early career management.
6	Options	To provide you with an opportunity to take responsibility for study in an aspect of physiotherapy at a greater depth or to explore an aspect of physiotherapy with which you are not yet familiar. In doing this you will evaluate and further develop your PDP.

Whilst it can be seen from Table 2.1 that there is no CVR-specific focus at level 4, transferable skills such as communication, professional practice, clinical reasoning and reflection were introduced and provided a good foundation on which the CVR-specific content could build in year 2. The Principles of Practice in the Cardiovascular-respiratory Physiotherapy (PRP) module was a compulsory, must-pass 20 credit level 5 module. It was the only specifically CVR focused module within the undergraduate programme. It was delivered alongside two other 20 credit specialism modules: musculoskeletal (MSK) and neurological (Neuro). A summary of the modules taught at level 5 (year 2) is provided in Table 2.2

The three specialism modules MSK, Neuro and CVR ran throughout the students' second academic year (Figure 2.1). Cardiac and pulmonary rehabilitation content was covered predominantly in the Rehabilitation of Functional Movement Module with links made to core content covered within the PRP module. Early rehabilitation in the ICU was covered in the level 6 Clinical Reasoning and Management module due to its complexity.

The aim of level 5 (year 2) was to build on the basic principles explored at level 4, through a range of clinically focused, applied modules and clinical placements to develop effective assessment, problem identification, goal setting and management strategies across a range of conditions and clinical presentations to prepare students for professional practice. The philosophy of rehabilitation, wellbeing, service-user centred care and enablement threaded through each module. In addition to the three specialist-specific modules, an exercise/rehabilitation module, a health promotion module as well as two interprofessional modules focusing on collaborative practice and evidence-based practice were delivered. Level 6 (Table 2.3) subsequently increased in both complexity and diversity. Moving beyond the core specialisms, the modules explored not only a range of more diverse specialisms and co-morbidities, but also wider healthcare service issues and leadership; as well as completing a dissertation. There was also the opportunity to choose an area of Physiotherapy not previously explored in detail. This included working with third sector organisations delivering a specific project based on need or arranging an overseas placement.

Figure 2. 1 Overview of the second year of study prior to redesign

<table>
<tr><th>WK</th><th colspan="4">Year 2</th></tr>
<tr><td>Sept</td><td colspan="4">Year 2 induction</td></tr>
<tr><td>Sept</td><td rowspan="2">Musculoskeletal module (PMP)</td><td colspan="2" rowspan="2">Neurological module (PNP)</td><td rowspan="2">Cardiovascular-respiratory module (PRP)</td></tr>
<tr><td>Sept</td></tr>
<tr><td>Oct</td><td colspan="4" rowspan="2">Inter-Professional Education modules</td></tr>
<tr><td>Oct</td></tr>
<tr><td>Oct</td><td rowspan="2">PMP</td><td colspan="2" rowspan="2">PNP</td><td rowspan="2">PRP</td></tr>
<tr><td>Oct</td></tr>
<tr><td>Nov</td><td colspan="2" rowspan="2">Promoting wellness through physiotherapy (PWTP)</td><td colspan="2" rowspan="2">Rehabilitation of Functional Movement (RFM)</td></tr>
<tr><td>Nov</td></tr>
<tr><td>Nov</td><td colspan="4" rowspan="5">Clinical Placement Block 2</td></tr>
<tr><td>Nov</td></tr>
<tr><td>Dec</td></tr>
<tr><td>Dec</td></tr>
<tr><td>Dec</td></tr>
<tr><td>Dec</td><td colspan="4" rowspan="2">XMAS BREAK</td></tr>
<tr><td>Dec</td></tr>
<tr><td>Jan</td><td colspan="4" rowspan="5">Clinical Placement Block 3</td></tr>
<tr><td>Jan</td></tr>
<tr><td>Jan</td></tr>
<tr><td>Jan</td></tr>
<tr><td>Jan</td></tr>
<tr><td>Feb</td><td colspan="2" rowspan="2">PWTP</td><td colspan="2" rowspan="2">RFM</td></tr>
<tr><td>Feb</td></tr>
<tr><td>Feb</td><td colspan="4">PWTP and RFM Assessments</td></tr>
<tr><td>Feb</td><td rowspan="5">PMP</td><td colspan="2" rowspan="5">PNP</td><td rowspan="5">PRP</td></tr>
<tr><td>Mar</td></tr>
<tr><td>Mar</td></tr>
<tr><td>Mar</td></tr>
<tr><td>Mar</td></tr>
<tr><td>April</td><td colspan="4" rowspan="2">EASTER BREAK</td></tr>
<tr><td>April</td></tr>
<tr><td>April</td><td colspan="4" rowspan="2">Assessment weeks PMP PNP PRP</td></tr>
<tr><td>April</td></tr>
<tr><td>May</td><td colspan="4" rowspan="5">Block 4</td></tr>
<tr><td>May</td></tr>
<tr><td>May</td></tr>
<tr><td>May</td></tr>
<tr><td>June</td></tr>
</table>

2.2 Module Overview

This section of the chapter outlines the Principles of Practice in Cardiovascular-Respiratory Physiotherapy (PRP) module prior to its redesign. Section 2.3 will then outline the rationale for change and the changes implemented.

2.2.1 Module Aims and Learning Outcomes

The aim of the module was to provide students with an introduction to the assessment and treatment of cardiovascular-respiratory problems and opportunities to develop a problem-solving and evidence-based approach to cardiovascular-respiratory physiotherapy, in order to enhance their clinical practice. The module Learning Outcomes on successful completion were for students to be able to:

1. Safely assess any cardiovascular-respiratory patient and formulate a detailed treatment strategy that also discusses the key principles of cardiovascular-respiratory pathology
2. Apply prioritisation skills to management in relation to the identified issues of a given respiratory patient
3. Provide a critical rationale for selected management strategies for this patient
4. Use supporting evidence from an appropriate source of literature to justify chosen interventions
5. Communicate findings in a structured manner following assessment, treatment planning and critical evaluation

2.2.2 Clinical Reasoning in the Context of the Study

The premise of the module was to provide students with the fundamental assessment and reasoning skills to be able to practise safely and effectively within the field of cardiovascular-respiratory (CVR) physiotherapy. As discussed in section 1.1.5, at the time of the study commencement, CVR Physiotherapy still practised predominantly within secondary and tertiary care settings, although cardiac and pulmonary rehabilitation were also very established areas within Physiotherapy. The focus of the PRP module, however, was the assessment and treatment of patients with acute cardiovascular-respiratory compromise; with cardiac and pulmonary rehabilitation explored in detail within the Rehabilitation of Functional Movement module.

Clinical Reasoning is a term that has been used to define the process of assessment, diagnosis, clinical decision-making, treatment selection and justification, (Higgs et al 2008; Edwards et al, 2004). It's evolution from deductive processes and diagnostic reasoning to today's more holistic approach that considers not only structures and functions but how someone participates in society, was outlined in section 1.1.3.

When designing the original learning and teaching approaches for the module, consideration was given to the development of clinical reasoning within the context of cardiovascular-respiratory physiotherapy and what skills the students would need to develop. Higgs, Richardson and Dahlgren (2004) identified eight strategies utilised to support clinical reasoning:

- Diagnostic: the process used to form a physiotherapy diagnosis or identify a patient's main problems
- Narrative: the processes used to understand client's interpretations of their illness experiences
- Procedural: the processes used to make decisions about physiotherapeutic interventions
- Interactive: approaches used to develop, establish and maintain effective interaction
- Collaborative: the processes involved in engaging with clients in a mutually agreed interpretation of problems, planning of interventions and decision-making
- Teaching: reasoning about the use of teaching in therapy
- Predictive: the processes of identifying the likely progression of a condition and response of the patient to proposed therapy
- Ethical: the process of identifying and resolving ethical issues that arise within a given situation

These eight strategies provide a broad framework underpinning the process of clinical reasoning and are reflective of the ways in which physiotherapists work in partnership with patients and their families to achieve the best outcome. However, in the context of the PRP module, greater emphasis was placed on diagnostic, narrative, procedural and collaborative strategies. This was in part due to students being at a relatively early stage of the programme with limited clinical experience on which to draw, and partly due to the clinical focus of the module. The implications of this decision and approach are discussed in Chapter 7.

In preparing the students for CVR physiotherapy practice consideration was given to their likely pattern recognition, prediction and problem-solving skills; and the range of skills that were required for successful completion of the module. Skill acquisition is seen as underpinning the development of expertise (Berliner, 1988), yet the students within the module would likely be deemed novices on the novice to expert spectrum (Higgs et al, 2008), as outlined in Table 2.4. Consideration was therefore given to cognitive processing differences between novices and experts as well as the strategies underpinning clinical reasoning when designing the module. The aim being to facilitate transition towards Advanced Beginner level of application of knowledge, analysis, decision-making and action.

Table 2.4 and Higgs et al (2008) Adapted Model of Skill Acquisition Created by Dreyfus (1972) and Benner (2004)

Stage	**Application of knowledge**	**Analysis**	**Decision-making**	**Action**
Novice (early training)	Factual	Limited perspective	Strict boundaries, relies on others	Follows rules and protocols
Advanced Beginner (early graduate practice)	Objective facts	Narrow situational perspective	Framework governed; relies on others for complex situations	Begins to use judgement within concrete situations
Competent (>2 years experience)	Hierarchical perspective	Conscious of situation	Makes decisions, feels responsible	Implements reasoned responses pertinent to situation
Proficient (transitional stage to expert)	Situational	Perceives whole situation	Makes decisions in complex situations	Intuitive behaviours replace reasoned responses
Expert	Selective and discerning	Judicious analysis of situation and awareness of when to act	Pre-emptive decision-making, goal orientated	Intuitive and deliberate rationality; where intuition not developed, reasoning is applied

The topics covered within the module that had the aim of developing clinical reasoning skills can be found in Section 2.2.5. Furthermore, the process by which students' clinical reasoning was evaluated is outlined in the Assessment Tasks for the Module (section 2.2.6.2). The literature pertaining to the process of clinical reasoning and the development of clinical reasoning skills in UG Physiotherapy education programmes is evaluated in Chapter 3.

2.2.3 Learning and Teaching Approaches in the Context of the Module

The module was delivered using face-to-face group sessions as well as an expectation that students would engage in self-directed learning opportunities and additional resources housed within the virtual learning environment (VLE) to explore subjects and case scenarios in more detail. In-class teaching was delivered in a range of environments: from flat seminar rooms to practical rooms and clinical skills suites. There were no lectures within the module. The underpinning pedagogies and how they relate to the L&T within the module are discussed below.

2.2.3.1 Behaviourism

Behaviourism in education often relates to the reinforcement of appropriate classroom behaviours and engagement with learning. Behaviourism rose to prominence in the early 20th century with psychologists such as Thorndike, Watson and Skinner (Stangor and Walingor, 2014). Thorndike hypothesised that there were associations between an experience and the resulting response. The premise of Behaviourism was conditioning, with positive reinforcement of correct actions and negative reinforcement as well as punishment apportioned for incorrect actions. Whilst much of Behaviourism has been discounted from facilitating meaningful, deep learning, it is still seen as relevant and often utilised as a means of managing classroom behaviours and the collective learning environment in primary and secondary education (Woolfson, 2011). However, because Higher Education is undertaken by adults, it could be argued that there should be little need for this approach to classroom management, as appropriate classroom behaviours should already be established.

In the context of HE today, behaviourism is relevant as the use of tablet and smart phone devices and the capturing of images/media within class requires an understanding of appropriate behaviours and is bringing about a change in conditioned response. Previously smart phones and tablets were seen as a disruption in class, with students expected not to utilise them during teaching (Nagler, Ebner, & Schön, 2017). Moving from this conditioned response (for both students and tutors) and establishing ground rules and boundaries of acceptable behaviour may therefore be required within the learning context to ensure ethical and professional practice. Furthermore, reinforcing appropriate behaviours and addressing inappropriate ones online is also of relevance as students are increasingly required to engage with online resources and discussions. Providing guidance to students within HE about appropriate online behaviours such as maintaining a professional online presence, appropriate communication and so on is key to developing digital literacy (JISC, 2015). Therefore, elements of behaviourism are still of relevance in modern HE.

2.2.3.2 Cognitivism

Cognitivist theories are concerned with the mental structures and processes required for us to learn (Ertmer, Newby and Medsker, 2013). Cognitivism is predominantly concerned with mental processing, investigating the components required to learn and factors that impact on the learning process. Cognitivism is ultimately an umbrella term; it is a culmination of many different models and theories all concerned with the process of learning itself. The underpinning foundations to most cognitive models of learning include elements of: the information gleaned from observing an action; the impact of performing the action in terms of an individual making sense of their actions prior to enactment; the resulting outcome; and the provision of feedback.

Piaget was one of the first cognitive theorists. He explored how thinking, learning and reasoning develops through childhood; and identified that learning was not a linear process into adulthood. Piaget theorised the way in which people think and process information changes not only with age, but also environment. Key to this theory was the mechanism of change that brings about learning. Piaget hypothesised a dynamic interplay of progressive equilibria as a result of adaptation and organisation (Piaget, 1976). Fundamentally, he hypothesised that new experiences brought about a destabilisation of what an individual already knows, causing them to re-conceptualise, makes sense and create new knowledge, i.e. develop a new state of equilibrium. The two processes he identified were assimilation and accommodation. Assimilation was the term defined to describe how an individual uses new experiences to consolidate and enhance what is already known; whilst accommodation, describes the process of new experiences bringing about a questioning and adjustment of prior knowledge.

When constructing the module teaching and learning activities, consideration was given to assimilation and accommodation as a means of developing clinical reasoning skills. In light of the taught content within level 4 (year 1), it was important not to overestimate the baseline CVR knowledge of students, as this could disrupt the balance between assimilation and accommodation. If a student has little pre-existing knowledge on which to assimilate, the balance shifts towards accommodation. However, the process of accommodation requires a foundation knowledge on which to build. If these foundations are insufficient, the journey to accommodation may not be achievable. It is these processes of acquiring and organising information through cognitive frameworks and structures, and an understanding of cognitive processes and possible barriers to learning, that enabled the researcher to construct learning to enable learners to develop the key underpinning skills required on which to progress to clinical reasoning.

2.2.3.3 Social Cognitive Theory

Social Cognitive Theory (SCT) began to emerge as a way of articulating some of the cognitive processes underpinning the learning experience; and the role others may have on an individual's learning potential. Social Cognitive Theory reinforced the post-behaviourist view that negative reinforcement alone was insufficient in correcting mistakes. It hypothesised that demonstration and observation of correct procedures prior to undertaking an action provided a more positive learning experience and outcome. In particular, the roles of observation, modelling, feedback and self-regulation were defined as key parts of SCT (Chandler and Munday, 2016). At the forefront of this was the work of Bandura (1986) who hypothesised that the person, their behaviours and the environment in which they were learning were also integral and influencing factors.

Key to the observational element within SCT was the differentiation between learning and performance. Learning could take place through observation alone; however, instruction and guidance were important to enable the assessment of performance. Bandura (1986) articulated different forms of observation and their relative impact in a learning as well as differentiating cognitive skill learning from motor skill learning. Latent learning was the observed learning in the absence of goals and/or reinforcement; and was a slower form of learning and of less significance. Vicarious Learning was the key to accelerating the learning process whereby learners could observe correct and incorrect procedures, and understand the processes involved before attempting to replicate that process.

SCT is fundamentally grounded in reciprocity, identifying Vicarious Learning and Enactive Learning (learning through doing), and the resulting outcome, as part of the reciprocal process. In addition to observation, Bruner also stipulated that learning through doing, or enactive learning, was essential (Bruner, 2009). SCT builds on this enactment but considers the person, behaviours and environment, identifying that modelling, as opposed to imitation, is key to developing learning through observation. Bandura (1986) identified three key functions to Modelling: response facilitation (i.e. social prompts and motivations); inhibition and disinhibition (i.e. creating parameters, expectations and behaviours); and observed learning (i.e. identifying new behaviours and actions that an individual would not otherwise perform). Cognitive skill learning through modelling was seen to be most effective when the demonstration is constructed to incorporate explanation and verbalisation with justification. In addition, combining errors, and how to identify and manage them into the demonstration was more effective than explanation alone. This approach to modelling enables the learner to process the skill, order it, understand and apply the learning. Once an individual has assimilated and accommodated new knowledge through the vicarious and modelling processes, learning through enactment is often undertaken (Bandura, 1986). Simulation was used within the PRP module to provide opportunities for enactment.

Many of the topics, concepts and skills explored within the PRP module were new to the student cohort. SCT and in particular demonstration, modelling, enactment and feedback played a significant part in the approach taken when developing history taking and clinical examination. Demonstrations in class were provided by module tutors with instructions and verbal commentary. Students would then work in groups on practical tasks with observers asked to provide constructive feedback to their peers in addition to the feedback provided by tutors.

Social Cognitive Theory and the role of demonstration, modelling, feedback and self-regulation underpinned a number of the redesign choices for the module. This is discussed further in section 2.3.

2.2.3.4 Constructivism

Vygotsky challenged the premise that learning and behaviour changes were a direct result of cognitive development and environment, and began to explore how societal influences and one's own experiences interacted with new situations to enable the construction and refinement of further knowledge and skills (Vygotsky, 1934 cited by Shabani et al, 2010). As a result, factors influencing the construction of knowledge and understanding were broken down into three premises: Exogenous, Endogenous and Dialectical. The premise of exogenous learning is the impact of external factors, frameworks and models in how new information and experiences are shaped; endogenous is how new experiences are constructed based on one's own internal influences, bias and values; and dialectical is the influence of collaboration and developing a broader understanding through the shaping of experiences based on others' perspectives.

Key to this theory is interplay and how individuals acquire knowledge for themselves through being actively involved in a situation (Kolb et al., 2001). Situated cognition, or situated learning, attempts to articulate the balance needed to be achieved between the three premises within the constructivist approach to learning. The fundamental principle is that context, or the situation, should act as the key factor in tying together the influence of external frameworks with the influence of one's own perceptions, alongside the opportunity for dialogue with others and rationalisation of contradictions that arise from the exogenous and endogenous premises. Applying a constructivist approach to learning, in theory, affords the student the opportunity to learn through the interplay of active experimentation, collaborative dialogue and supportive discourse. Constructivism applied in a L&T context therefore encourages a move away from traditional instructional techniques to a more dynamic learning experience for the student, moving beyond observation and enactment alone.

Constructivism encourages a move towards minimal instructional guidance (Bruner, 2009); with activities designed to enable the learner to scaffold their own learning through exploration. Problem-based learning, for example, is an approach that is underpinned by constructivism, whereby students are provided with a situation (problem) to explore, with 'triggers' to help guide the direction of exploration. There is much literature in support of the efficacy of this approach in medical education (Dochy, Segers, Van den Bossche, and Gijbels, 2003; Koh, Khoo, Wong, and Koh, 2008; Vernon and Blake, 1993 cited by Allen et al, 2011). However, one of the criticisms levied at problem-based learning, and constructivism in general, is the extent to which students are required to direct their own learning (Kirschner, Sweller and Clark, 2006). Without appropriate structure and scaffolding, learners can formulate knowledge that is influenced primarily by endogenous and dialectical factors, but devoid of necessary underpinning theoretical understanding. Whilst constructivism no doubt facilitates an individual drawing their own conclusions and opinions, it does not necessarily guarantee the accuracy of understanding relative to a specific topic. In addition, as the learning is often context-dependent, it is unclear how easily healthcare undergraduate students in the early part of their studies are able to apply and transfer learning to different healthcare contexts.

With the module occurring early in year 2 of the undergraduate programme, and the content being an area not previously explored within the curriculum, Constructivism did not feature heavily as a teaching and learning approach in the early stages of the module. Previous student feedback indicated a less positive experience when a more constructivist, student-directed learning approach was taken within the module; with this being considered as part of the redesign outline in section 2.3 of this chapter.

2.2.4 Module Delivery

The original iteration of this module ran from September until the end of April and was interspersed by the level 5 Inter-Professional Education (IPE) modules, two 5-week clinical placements, the winter and Easter vacation breaks and all other level 5 (year 2) modules as outlined in Figure 2.1 earlier in this chapter. As can be seen from the diagram, there were short clusters of weeks for teaching delivery with a number of breaks truncating the module. As this was level 5, the expectation of students on placement was such that they would be required to assess patients, identifying main problems and suggest appropriate management /rehabilitation strategies. It was therefore important to equip the students with the necessary baseline cardiorespiratory knowledge and skills prior to the two clinical placement blocks on which they could apply, consolidate and build.

One of the challenges with the original delivery timeline was the truncated nature of the module as seen in figure 2.1. Due to the concurrent delivery of other modules, teaching for PRP was often clustered into short bursts interspersed by blocks of teaching on other modules and 2 clinical placements. Whilst the programme had been designed to enable the cross-signposting of core content across the CVR specialism, rehabilitation and health promotion modules, in practice students reported being distracted confused as to which content resided in which module. Furthermore, the 16 weeks during which the students were out on placement or studying IPE modules resulted in a long gap between the initial module teaching and returning to consolidate and develop new understandings in preparation for the module assessment tasks. Feedback on the timing of teaching delivery, and the impact this was having on the learning experience, was one of the impetuses for reviewing the module.

2.2.5 Module Content

Prior to the re-design, the module was delivered as outlined in table 2.5. The module commenced with an introductory session outlining the module structure, the use of online case studies, formative on-line MCQs and the bespoke self-assessment questionnaire for use to guide the identification of learning objectives within the two clinical placement blocks. The module's summative assessment tasks were also introduced in this initial session. The remaining teaching followed the format of seminars and practical sessions.

In addition to the truncated nature of the module's delivery schedule, as outlined in the previous section, students indicated that several core topics were difficult to understand and apply to the clinical context. Students also reported that the approach to teaching was not conducive for developing understanding or facilitating knowledge to clinical practice, with a preponderance towards didactic delivery, large volume of theoretical content and lack of revisiting of topics. Additional student feedback and the impetus for redesigning the module are provided in section 2.3.

Table 2.5 Summary of topics covered within the module

Week	Session		Overview of content
8	1 2 3	Introduction Seminar Practical	Introduction to module Respiratory assessment Cardiovascular assessment
9	4 5	Seminar Seminar	Impact of environment: consideration of the impact different environments has on the assessment of a patient with respiratory insufficiency Understanding and interpreting arterial blood gases (ABG's)
10 & 11			Self-directed learning - Contribute to wiki case studies: history taking and formulation of a holistic respiratory assessment
12	6 7 8	Practical Seminar Seminar	Ventilation/Perfusion and implications for physiotherapeutic management Pathology recognition (i) - impact and clinical presentation of secretion retention Pathology recognition (ii) - impact of loss of functional lung volume. - linking sputum retention and loss of volume - developing understanding of COPD
13	9 10 11	Seminar Seminar Practical	Pathology recognition (iii) - interpretation of CXR's and linking to pathologies/clinical presentation Problem identification and goal setting Airway clearance and respiratory techniques
14-30			**Clinical Education Blocks 2 & 3** Self-directed learning - Contribute to wiki case studies: Formulation of a holistic respiratory assessment, problem identification
31	12	Seminar	Evaluation of practice in respiratory care
32	13 14	Practical Practical	Oxygen therapy, assessment of need, titration and humidification Principles of ventilation
33	15 16	Practical Practical	Rehabilitation of the respiratory patient Introduction to SIMMAN
34	17	Practical	SIMMAN practical
35	18	Practical	Formative SIMMAN assessment
35			**Hand-in written assignment** The submission date for your written assessment task (task B) is **3 pm Friday 30th March**
38 & 39			**Summative SIMMAN assessment** (see BB site for details and assessment timetable)

2.2.6 Assessment Strategy in the Context of the Module

This section outlines the underpinning assessment strategies and the range of formative and summative assessment activities within the module. Formative assessment is defined as assessment that has been designed to further the development of the learner through the effective use of feedback and identification of means by which learners can improve (QAA, 2018). In contrast, summative assessment is identified as the means to indicate the extent of a learner's success in meeting the assessment criteria (QAA, 2018).

When designing the assessment tasks for the module a number of key factors influenced decisions. Core to these decisions was the need to ensure an authentic assessment experience that aligned to learning outcomes and teaching activities, that also enabled the module tutors to effectively and consistently assess the clinical reasoning skills of students in the field of CVR physiotherapy. Another key factor that influenced the choice of assessment tasks was the requirement for this module to provide an opportunity for students to develop their critical evaluation of the available literature as well as academic writing skills in preparation for their final year of study and the completion of their dissertation. A prior decision by the course writing team was that the PRP should be the one specialism module at level 5 (year 2) to have a written summative task in addition to a practical one. The rationale being that students needed opportunities to develop their academic writing and critique of the literature in preparation for their dissertation in the final year.

Maslow theorised 4 stages of learning in relation to skill acquisition: unconscious incompetence, conscious incompetence; conscious competence and unconscious competence (Manthey and Fitch, 2012). As previously discussed, competence in Physiotherapy includes the ability to assess a situation, determine the nature and severity of the problem and call upon the required knowledge, skill and experience to deal with the problem (HCPC, 2013). Designing an assessment task that enables a meaningful evaluation of an individual's ability and, in this case, clinical competence in the university environment can prove challenging in terms of authenticity. Assessing an individual's competency in a particular skill via a standardised assessment, as is often the case in healthcare education, could be seen as reductionist and task orientated. This model of assessment does not necessarily represent an individual's ability in the wider clinical context or their clinical reasoning skills (Watson et al, 2002; Dolan 2003). However, it is necessary to assess students' ability against the Standards of Proficiency to ensure graduates are safe to practise (HCPC 2013) so a standardised, measurable task is required.

Whilst it could be argued that more meaningful and continual assessment could, and does, occur whilst on placement, it is not guaranteed that all students will have particular clinical experiences on which they can be assessed. Therefore, in order to assess students against all SoPs it is important to ensure sector-recognised, standardised assessments are employed (QAA, 2018).

The truncated nature of the module delivery pattern also highlighted the role of formative assessment to maintain and facilitate ongoing learning throughout the academic year. These were designed to enhance the applied nature of the learning experience whilst also providing a regular means of feedback. The formative activities aligned to the assessment for learning philosophy as the premise was to facilitate learning through dialogue and feedback centred around case studies that students would contribute to in groups. No marks were attributed to these activities and the feedback was available for all students to access. Optional MCQs were also released at key points through the academic year for students to check their knowledge and understanding. The value of MCQs in assessing knowledge and understanding is provided in section 4.6.1.

2.2.6.1 Assessment for Learning

Assessment for learning is a term that has gained more traction with educationalists in recent years (Sambell, McDowell, & Montgomery, 2013). Its premise is to facilitate student learning through the process of assessment where the facilitation of learning is the predominant priority of its design (Knight, 2012). Assessment for learning has been said to focus on how students learn and should be integral to the learning and teaching design (Boud & Falchikov, 2007). Tutors designing assessment for learning opportunities are advised to consider learner motivation and ensure a clear shared understanding of the criteria by which the tasks are measured (Wyatt-Smith, Klenowski, & Colbert, 2014). Alongside this is an expectation that assessment for learning develops the learner's capacity for self-assessment and reflection. The concept of assessment for learning resonated with the researcher both in terms of the principles underpinning the design choices and in light of self-assessment and reflection being core skills required of a practising Physiotherapist (HCPC 2013). Self-assessment and reflection were already actively incorporated within the module through the self-assessment questionnaire students were asked to complete prior to the clinical placement blocks.

Assessment for learning differs from formative assessment as the purpose of formative assessment is not attributing a mark or grade but providing an opportunity to understand progress and identify ongoing learning needs (Sambell et al., 2013) Therefore, whilst formative assessment may often facilitate learning, it should not be assumed that formative assessment has been designed with that as its primary objective. It can also be argued that summative assessment can be deemed assessment for learning if tasks are designed with the purpose of enabling learning through the process of assessment itself. Within the PRP module, summative assessment tasks were designed to provide a meaningful, clinically relevant assessment experience through the use of a simulated case study and a written, evidence-based management plan for a give case study. The tasks themselves are outlined in the subsequent section and discussed further in Chapter 7 in light of the study's findings.

2.2.6.2 Assessment Tasks for the Module

When designing the module's assessment strategy, consideration was given to the best means of assessing a student's cardiorespiratory clinical reasoning skills in an authentic manner that best prepared them for clinical practice in addition to the need to incorporate a written assessment task. Two tasks were therefore designed. One was a real-time assessment of a simulated case study with a discussion of the assessment findings with an examiner and the identification of a prioritised problem list. The other was a written assignment requiring an evidence-based justification for a chosen treatment plan and/or management strategy for a given case study. These two tasks enabled all the learning outcomes for the module to be effectively assessed and enabled students to demonstrate their learning both verbally and in written form.

The module's assessment strategy incorporated a range of formative and summative tasks. Ongoing formative feedback was provided throughout ranging from feedback and discussion of student-generated resources to feedback on simulated activities. Throughout the module there was the provision of formative feedback to help students identify any ongoing learning needs and develop the application of knowledge and understanding within cardiovascular-respiratory care. The MCQs interspersed throughout the teaching weeks also provided feedback, enabling students to ascertain their own knowledge and learning. A mock practical exam was also provided to prepare students for the summative assessment process and conditions. The latter was introduced in response to students indicating they did not know what to expect from the practical assessment task.

In addition, students were provided with video examples of the assessment task, asked to mark a demonstration video and discuss the marks they would have awarded. The purpose was to facilitate greater engagement with the marking criteria and better understanding of how it would be used to assess attainment against the learning outcomes.

Assessment task 2 comprised a written discussion and evaluation of the literature pertaining to a respiratory intervention for a particular case study that the student was familiar with (1500 words). Students were required to select one case study from a range of six and identify the case study's main problems (linking them to the underlying pathophysiology, the overall clinical presentation and wider personal/environmental considerations). They were asked to select and rationalise a physiotherapeutic intervention for their chosen case study and then critically analyse a range of literature to justify the intervention.

Learning outcomes 1, 2 and 5 were assessed in assessment task 1, with LOs 3, 4 and 5 being assessed in task 2. Table 2.6 depicts the assessment criteria used for the simulated task. As can be seen from the marking criteria, assessment was made against some of the identified strategies underpinning clinical reasoning, namely diagnostic, narrative, procedural and collaborative.

The written assessment task was marked by the module team who had undergone a consistency exercise prior to the assessment task. Table 2.7 indicates the marking criteria used to assess the written task. All markers were internally moderated by a member of staff external to the module but within the subject group, and by an external examiner.

In designing the simulated assessment task the module tutors aimed to provide an authentic acute CVR clinical scenario that would enable students to demonstrate their ability to take an appropriate patient history, clinically examine the mannikin, collate object assessment data; and discuss problem identification and goal setting with the examiner. When considering the eight strategies that underpin clinical reasoning, it is can be argued that the strategies being utilised most within this assessment task are Diagnostic, Procedural and Predictive. Whilst these are valid and appropriate strategies to assess, the simulated scenario was limited in its ability to enable Narrative, Collaborative or Interactive strategies to be drawn upon or indeed assessed. From this it can be seen that the assessment task was situated within the Structure and Function domain of the ICF, aligning to a more medical model of practice.

Whilst it could be argued that the simulated assessment task took a narrow perspective on clinical reasoning, consideration was afforded when designing the task of the level of ability expected of these students. Novice practitioners are said to be based in facts, follow rules and protocols, with limited perspective and strict boundaries (Higgs, Richardson, & Dahlgren, 2004). Whilst the purpose of the UG education programmes is to facilitate students to 'Advanced Beginner' status upon graduation, whereby they are able to use their own judgement and draw in situational perspectives, the students undertaking this module were only half-way through their course. It was important therefore, to strike a balance between Novice and Advanced Beginner expectations of assessment. The ability of the assessment task to assess clinical reasoning and reflect the range of skills required to work within contemporary CVR physiotherapy services is considered within section 7.3.1.

Table 2.6 Marking grid for simulated summative assessment

LO	<30	30- 39	40-49	50-59	60-69	≥70
Safely assess a respiratory patient and formulate a detailed treatment strategy that also discusses the key principles of cardiorespiratory pathology	You were unable to demonstrate a logical or coherent respiratory assessment and/or treatment strategy. You offered little or no discussion of the key principles of cardiorespiratory pathology or the influence of psychosocial factors	You attempted to demonstrate a respiratory assessment and/or treatment strategy, but this was inaccurate and lacked cohesion or clarity. You attempted to discuss the key principles of cardiorespiratory pathology and the influence of psychosocial factors, but this was mainly inaccurate.	Your demonstration of respiratory assessment and your treatment strategy was clear and mainly correct. You accurately discussed some of the key principles of cardiorespiratory pathology and the influence of psychosocial factors, however this was superficial.	You demonstrated a clear and logical respiratory assessment and treatment strategy. You accurately discussed the most relevant key principles of cardiorespiratory pathology and also the influence of psychosocial factors. There were only a few, minor inaccurate or illogical links made.	You demonstrated a thorough respiratory assessment and treatment strategy. You offered a comprehensive discussion of the key principles of cardiorespiratory pathology and the influence of psychosocial factors, making strong links between theory and practice.	You demonstrated a comprehensive and insightful respiratory assessment and treatment strategy. You offered a detailed and extensive discussion of the key principles of cardiorespiratory pathology and the influence of psychosocial factors, integrating theory and practice.
Apply prioritisation skills to management in relation to the identified issues of a given respiratory patient	There was little or no interpretation of the essential assessment findings and little/no evidence of a prioritised problem list	The interpretation of the essential assessment findings to justify a prioritised problem list lacked depth and clarity in the way that it was related to the clinical situation	The interpretation of the essential assessment findings to justify a prioritised problem list had some depth and clarity in the way that it was related to the clinical situation	A detailed interpretation of the essential assessment findings was provided offering depth and clarity related to the clinical situation. Strong justification was given for the prioritised problem list	A thorough interpretation of the essential and more subtle assessment findings was provided related to the clinical situation. Detailed justification was given for the prioritised problem list which was wholly appropriate.	A holistic interpretation of the essential and more subtle assessment findings was provided related to the clinical situation. Detailed justification was given for the prioritised, insightful problem list.

LO	<30	30- 39	40-49	50-59	60-69	≥70
Communicate your findings in a structured manner following assessment, treatment planning and critical evaluation	You failed to clearly communicate your findings. Terminology used was inaccurate and/or applied incorrectly. Few or no references were used and these were not appropriate or relevant to the subject being discussed.	Your (verbal/written) presentation was not clearly structured. Terminology used was inaccurate and/or applied incorrectly at times. An insufficient number of references were used and were not appropriate or relevant to the subject being discussed.	Your (verbal/written) presentation was generally clear, structured and logical. Terminology used was accurate and applied for the most part correctly. A sufficient number of references were used and were appropriate and relevant to the subject being discussed.	Your (verbal/written) presentation was clear, structured and logical. Terminology used was accurate and applied correctly. A large number of references were used and appropriate and relevant to the subject being discussed.	Your (verbal/written) presentation was logically organised and flowed well. Terminology used was accurate and applied correctly. A wide variety of references were used and appropriate and relevant to the subject being discussed	Your (verbal/written) presentation was fluent, interesting and had a consistently logical structure. Terminology used was accurate and applied correctly. A wide variety of appropriate and relevant references were integrated into the subject being discussed.

Table 2.7 Marking grid for the written summative assessment

LO	<30	30- 39	40-49	50-59	60-69	≥70
Provide a critical rationale for selected management strategies for this patient	You were unable to demonstrate adequate knowledge of key aspects of cardiorespiratory problems and/or the influence of psychosocial factors. You were unable to discuss key physiotherapeutic skills to the given situation. You did not identify appropriate underpinning processes in the selection of techniques, rationalise their safety or offer consideration of their efficacy in relation to the cardiorespiratory problems.	You made attempts to demonstrate knowledge of cardiorespiratory problems and the influence of psychosocial factors but failed to identify the key aspects pertinent to the situation. You attempted to discuss physiotherapeutic skills but these weren't appropriate to the given situation. You attempted to identify appropriate underpinning processes in the selection of techniques, but the rationalisation was not appropriately justified. You struggled to consider safety and offered little consideration of their efficacy in relation to the cardiorespiratory problems.	You demonstrated knowledge of key aspects of cardiorespiratory problems and the influence of psychosocial factors pertinent to the situation. You were able to discuss key physiotherapeutic skills to given situations. When doing this you identified some underpinning processes in the selection of techniques, rationalised their safety and offered some consideration of their efficacy in relation to the cardiorespiratory problems identified.	You demonstrated detailed knowledge of key aspects of cardiorespiratory and the influence of psychosocial factors problems pertinent to the situation. You were able to discuss key physiotherapeutic skills to given situations. When doing this you identified most fundamental underpinning processes in the selection of techniques, rationalised their safety and offered consideration of their efficacy in relation to the cardiorespiratory problems identified.	You demonstrated detailed knowledge of all key aspects of cardiorespiratory problems and the influence of psychosocial factors pertinent to the situation. You were able to discuss key physiotherapeutic skills to given situations. When doing this you identified all fundamental underpinning processes in the selection of techniques, rationalised their safety and offered detailed consideration of their efficacy in relation to the cardiorespiratory problems identified.	You demonstrated excellent knowledge of all key aspects of cardiorespiratory problems integrating the influence of psychosocial factors pertinent to the situation. You discussed in detail key and less obvious physiotherapeutic skills to given situations. When doing this you integrated a variety of appropriate underpinning processes in the selection of techniques, rationalised their safety and offered insightful consideration of their efficacy in relation to the cardiorespiratory problems identified.

LO	<30	30- 39	40-49	50-59	60-69	≥70
Use supporting evidence from an appropriate source of literature to justify your interventions	You offered little evaluation of the literature relating to cardiorespiratory physiotherapy. You were unable to use this evaluation and offered little/no comment on the practice of the respiratory physiotherapist.	You made attempts but failed to identify the key aspects pertinent to the situation. You offered some comment on the practice of respiratory physiotherapy, but this was not substantiated	You demonstrated some evaluation of the literature relating to cardiorespiratory physiotherapy. You used this evaluation to offer some comment on the practice of the respiratory physiotherapist.	You demonstrated some critical evaluation of the literature relating to cardiorespiratory physiotherapy. You used this evaluation to offer judgements on the practice of the respiratory physiotherapist.	You demonstrated consistent critical evaluation of the literature relating to cardiorespiratory physiotherapy. You used this evaluation to reflect on the practice of the respiratory physiotherapist providing reasoned judgements and rationale	You demonstrated comprehensive and detailed critical evaluation of the literature relating to this. You integrated this evaluation offering considered judgements on, and reflection as to the practice of the respiratory physiotherapist.
Communicate your findings in a structured manner following assessment, treatment planning and critical evaluation	You failed to clearly communicate your findings. Terminology used was inaccurate and/or applied incorrectly. Few or no references were used, and these were not appropriate or relevant to the subject being discussed.	Your (verbal/written) presentation was not clearly structured. Terminology used was inaccurate and/or applied incorrectly at times. An insufficient number of references were used and were not appropriate or relevant to the subject being discussed.	Your (verbal/written) presentation was generally clear, structured and logical. Terminology used was accurate and applied for the most part correctly. A sufficient number of references were used and were appropriate and relevant to the subject being discussed.	Your (verbal/written) presentation was clear, structured and logical. Terminology used was accurate and applied correctly. A large number of references were used and appropriate and relevant to the subject being discussed.	Your (verbal/written) presentation was logically organised and flowed well. Terminology used was accurate and applied correctly. A wide variety of references were used and appropriate and relevant to the subject being discussed	Your (verbal/written) presentation was fluent, interesting and had a consistently logical structure. Terminology used was accurate and applied correctly. A wide variety of appropriate and relevant references were integrated into the subject being discussed.

2.3 Module Redesign

2.3.1 Impetus for Change

The precursor to this study was the review and redesign of the PRP module, driven by students. Feedback from the module outlined in section 2.2 was obtained via informal group meetings with those students who were undertaking the module at the time as well as staff-student committee meetings. Perspectives in relation to the structure, content, assessment, quality and vibrancy of L&T approaches were gathered. Students reported that due to minimal preparatory content being covered at level 4, the level 5 cardiorespiratory module required them to 'hit the ground running'. The module was commonly described as the hardest module in the second year and was often reported as the least favoured speciality. This is in keeping with reported student perspectives of CVR Physiotherapy (Roskell and Cross, 2003).

Student raised concerns that some topics were too complex, covered too quickly and/or not revisited; limiting opportunities to consolidate knowledge. Students also reported that most of the cohort had limited clinical experience within the CVR specialism and hence found application to a clinical context extremely challenging. This was of paramount importance to the researcher as application to clinical practice was the underpinning premise of the module. Students indicated that they enjoyed the group activities, but they felt there was too much emphasis on student-led group work, with little knowledge base on which they could draw.

In approaching the redesign of the module, it was important to understand which theories and topics proved most difficult for students, and what barriers there might be transferring learning to clinical practice. This was an integral component to the co-design process outlined in the Preface. It became apparent through dialogue with students that the academic staff had misjudged which aspects of the CVR curriculum would be most challenging. Whilst the previous had been designed by experienced academics, it was surprising how much disparity there was between staff and students as to which topics were most challenging. The approach taken to the redesign of the module provided a much better platform where students voices were sought and listened to.

2.3.2 Threshold Concepts

Much of the module discussions focused on which topics were most challenging, why, and ways in which understanding could be improved. These topics and consideration of why they were challenging in the eyes of students led the identification of some topics being classed as a Threshold Concept (Meyer and Land 2003). A Threshold Concept has been described as something that enables a new, transformed way of understanding; and without such understanding, further progression cannot be achieved (Meyer and Land, 2005). It is this transformative property that has been described as being an essential characteristic of a Threshold Concept (Baillie, Bowden and Meyer, 2013) coupled with being integrative, linking previously un-connected understanding and perspectives (Meyer, 2016). Additional characteristics of a Threshold Concept include being irreversible, bounded and troublesome.

Irreversibility is an important characteristic of a Threshold Concept (Walker, 2013) as once acquired, this newly transformed way of viewing the topic is likely to be permanent. This characteristic separates a Threshold Concept from subject matter that is merely difficult to remember. Often topics such as Arterial Blood Gas Analysis within CVR Physiotherapy are deemed challenging by students. However, as the process of analysis follows discrete steps, with fixed norms and patterns. It is therefore possibly less likely to be identified as a Threshold Concept.

One of the challenges levied at Threshold Concepts is in their identification (Barradell, 2013), with transactional curriculum inquiry (Cousin, 2009) being seen as the process by which to agree what is classed as a Threshold Concept. By engaging in group discussions with students in the early stage of module redesign, it was possible to identify common topics that were troublesome, what they felt the barriers to understanding was and what areas they were unable to grasp as a result of not understanding that topic. Through detailed questioning, it was possible to unpick those topics that students found difficult to retain, wit those they found difficult to conceptualise, understand and apply.

A further consideration of Threshold Concepts is the integrative nature of the topic. A Threshold Concept should be one that provides hidden links between ideas and concepts (Meyer & Land, 2003). This characteristic is said to be the antithesis of a full curriculum, where the focus is not on the delivery of large quantities of teaching and learning resources. Instead, the relationships between knowledge carry equal importance (Walker, 2013). This is an important consideration in light of student feedback about the module indicating it was overwhelming due to the amount of content and topics covered.

Through discussions it became apparent that developing an understanding of how different pathologies may present was integrated with and bounded by their understanding of the physiological principles. Students identified there was a disconnect in their understanding between normal lung mechanics and physiology and the pathophysiological changes that were explored relative to specific conditions. It was their lack of understanding of these processes and the effect they were having on the cardio-vascular system that limited their ability to link them to clinical presentation, signs and symptoms. This, they reported, led to a formulaic approach to clinical examination where they were able to undertake a standardised respiratory assessment, but were unable to interpret and rationalise their findings. It could be argued that these behaviours indicated students were mimicking the process of patient assessment and problem identification, rather than understanding why their patients were presenting as they were. The students could be described as exhibiting a state of liminality, associated with the difficulty in understanding a threshold concept brings (Meyer & Land, 2003). This in turn impacted on problem identification and selection of appropriate intervention/ management strategies.

Whilst it could be argued that it was the process of clinical reasoning itself that was the Threshold Concept in this instance, students were clear that a revised approach to L&T and different types of resources would unlock this troublesome knowledge and facilitate better understanding and application to practice.

2.3.3 Revised Module Content and Delivery

Subsequent to the identification of key Threshold Concepts, content, sequencing of topics and pacing were revised and redeveloped. A key change included restructuring the delivery of the whole academic year (Figure 2.2). Rather than the module spanning the full academic year and being interspersed by two clinical placement blocks and all other modules, the three specialist modules were now only interspersed by the IPE modules and the one clinical block. This enabled more of the teaching delivery to be scheduled before students went out onto placement and helped address concerns over split attentions and maintaining the thread of the module.

Figure 2. 2 Teaching delivery schedule for Level 5 (year 2) following redesign

W/B			
Sep	**END OF SUMMER VACATION**		
Sep	**Year 2 induction**		
Sep	Musculoskeletal module	Neurological module	Cardiorespiratory module
Sep			
Oct			
Oct	Inter-professional Education modules		
Oct			
Oct			
Oct			
Nov			
Nov	Clinical Placement Block		
Nov			
Nov			
Dec			
Dec			
Dec			
Dec	**WINTER VACATION WEEKS**		
Dec			
Jan			
Jan			
Jan			
Jan	**Reading week and assessment support**		
Feb	**Assessment weeks**		
Feb			
Feb	Clinical Placement Block		
Feb			
Mar			
Mar			
Mar			
Mar			

In addition to changes to the module delivery pattern, alterations were made to both the learning, teaching and assessment approach, and the resources used. A more graduated approach to the module was taken with topics being introduced, then explored in more detail and applied to different clinical contexts. The rationale for a more graduated approach was in response to students reporting feeling overwhelmed by content. As can be seen from Table 2.8, the topics covered remained largely the same, but it was the L&T approach and the range of resources that changed significantly. By integrating a range of different delivery methods, new resources as well as a drastically different module structure, staff were aligning to Bruner's assertion that delivery method as well as the content are key to the understanding and the grasping of new knowledge (Bruner, 2009). Furthermore, staff were able to address student comments about lack of opportunity to revisit key topics. As a result, the module incorporated opportunities to revisit and consolidate certain topics at the point of re-convening following the winter vacation.

The purpose of the redesign was to address student feedback and better develop clinical reasoning through a balance of assimilation, accommodation, adaptive environment, instruction, feedback and experimentation. Students requested that learning materials and resources be developed in a range of different formats and media to better facilitate the application and transference of university-based teaching into clinical practice. Most of these resources and activities included the use of technology, with Augmented Reality (AR) used to supplement simulation activities, Virtual Reality (VR), video-based resources and blended learning featuring heavily. The details of which can be found within the subsequent sections of this chapter.

Key to the redesign and the facilitation of knowledge and clinical reasoning skills was the use of formative assessment and feedback. Structured formative activities and provision of regular feedback were therefore integrated throughout the module, as a means of enabling staff to identify the range of understanding, facilitate learning and tailor the scaffolded learning incrementally.

The co-design process adopted for the module redesign, as outlined in the Preface, was also fundamental. It was therefore important to ensure the student learning experience was captured following the redesign instigated and developed in partnership with students, to ascertain whether the student ambitions of a more meaningful, applied learning experience were realised.

Table 2.8 An overview of the topics covered following redesign

Week	**Session**		**Overview of content**
7		Introduction	Introduction to the module Knowledge check
8	1 2 3	Seminar Practical Seminar	Cardio-Respiratory anatomy and physiology Ventilation and perfusion distribution; effects of positioning Understanding respiratory assessment
9	4 5 6	Practical Seminar Seminar	Cardiovascular assessment - incorporating practical assessment skills stations for auscultation, percussion note, palpation etc Impact of environment: consideration of the impact different environments has on the assessment of a patient with respiratory insufficiency Understanding and interpreting arterial blood gases (ABG's) - including gas transport, oxygen dissociation curve, CO_2 transport and acid-base balance
10	7 8 9	Seminar Seminar Seminar	Pathology recognition (i) - impact and clinical presentation of secretion retention Pathology recognition (ii) - impact of loss of functional lung volume. - linking sputum retention and loss of volume - developing understanding of the pathophysiology and clinical presentation of COPD Pathology recognition (iii) - interpretation of CXR's and linking to pathologies/clinical presentation
11			Knowledge Re-check - Formative MCQ
13	10 11	Seminar Practical	Problem identification and goal setting Airway clearance and respiratory techniques
14	12 13	Practical Practical	Oxygen therapy, assessment of need, titration and humidification Principles of ventilation Self-Assessment and MCQ
15	14 15	Practical Seminar	Rehabilitation of the respiratory patient Evaluation of practice in respiratory care – introduction to written assessment task
16-20			**Clinical Education Block 2** Self-directed learning –
21		Seminar	Written assignment support sessions
24	16	Practical	Introduction to SIMMAN
25	17	Practical	SIMMAN practical
26	18	Practical	Formative SIMMAN assessment Self-assessment and revision planning + MCQs
27			**Hand-in written assignment** The submission date = **4pm on Monday 28th January 2013**
28			**Summative Simman assessment**

2.3.4 Simulation, Augmented and Virtual Reality

Simulation has been shown to be effective in developing clinical reasoning and decision-making through undertaking simulated real-world scenarios (Bradley, 2006). Simulation affords the opportunity to perform tasks, reflect on performance and consider outcomes (Cook, Levinson, Garside, 2011). An essential component of clinical reasoning in the context of simulation is pattern recognition and experiencing deviations from the expected pattern. It is widely accepted as a means to support both undergraduate and post graduate nursing, medical and physiotherapy education (McGaghie et al 2006; Blackstock and Jull, 2007; Ricketts, 2011; Berragan, 2011; Brewer, 2011) and has been linked to the development of clinical competence and improved patient outcomes. The supporting educational theory for the use of virtual and simulated environments often refers to Social Cognitive Theory, Constructivism, Experiential Learning, deliberative practice and the mental model (Burke and Mancuso, 2012). However, the ways in which simulation can is implemented in UG healthcare education programmes varies widely. It is this variation in simulated learning practice that appears to affect learning in different ways. An exploration of the literature available at the time of study commencement is provided in Chapter 3, influencing both the utilisation of simulated learning provision within the CVR module and methodological choices for this study.

However, for those students with no, or very limited, prior clinical experience of cardiorespiratory physiotherapy, the scenarios used within the module were reported as too abstract and the simulation manikins lacking realism. Students reported that as they were unable to relate to how a situation would 'play out' in clinical practice, they went through the motions of a clinical assessment, not knowing what to expect in practice. This mirrored staff observations at the time that many students appeared to be formulaic in their approach to clinical assessment which, on questioning, they were unable to justify or explain. When undertaking simulated scenarios, participants are required to act out the scenario in line with normal roles and responsibilities. However, in the context of this module students were unable to immerse themselves into an expected role or recognise deviations from expected patterns. It was this lack of actual clinical experience, coupled with a lack of realism, that provided a challenge to the simulated learning and teaching activities woven into the module. This exemplifies the challenge in achieving Piaget's theory of equilibrium (Piaget, 1976). Assumptions had been made by staff that sufficient foundation knowledge and understanding existed with students on the module on which to assimilate. However, having little or no practical experience on which to draw meant that students were unable to build and accommodate new knowledge.

Furthermore, the repeated use of a small number of simulated case studies to develop confidence and skills in the process of clinical examination and history taking had been utilised for a number of years; however, students found it more challenging to articulate why they were performing certain tasks, or indeed how to adapt their approach for different situations. The approach to simulation had been to use medium fidelity simulation facilities consisting of a 'mocked-up' hospital ward environment and a mannikin exhibiting some limited clinical signs. Students were then asked to perform full patient examination, undertaking observation, auscultation and palpation; drawing additional clinical information from the monitors and the tutor facilitating the scenario. However, despite using simulation to support the development of clinical assessment and reasoning skills, students reported that the scenarios were devoid of realism and context to them, limiting their ability to immerse themselves in the scenario.

In the other specialism modules, patients with neurological or musculoskeletal conditions would be invited into teaching sessions for students to gain practical experience of actual patients in a facilitated learning environment. However, incorporating appropriate patients within the cardiorespiratory module was far more challenging. Whilst it was possible to invite patients with stable cardio-respiratory conditions into the module, it was not feasible, ethical, or indeed safe to ask patients with worsening respiratory symptoms to attend teaching sessions. Yet it was these very symptoms that students reported difficult to visualise and apply to a clinical context. It was also these symptoms that were the hardest to emulate on the simulation manikins.

2.3.4.1 Simulation, AR and VR Developments as a Result of Module Redesign

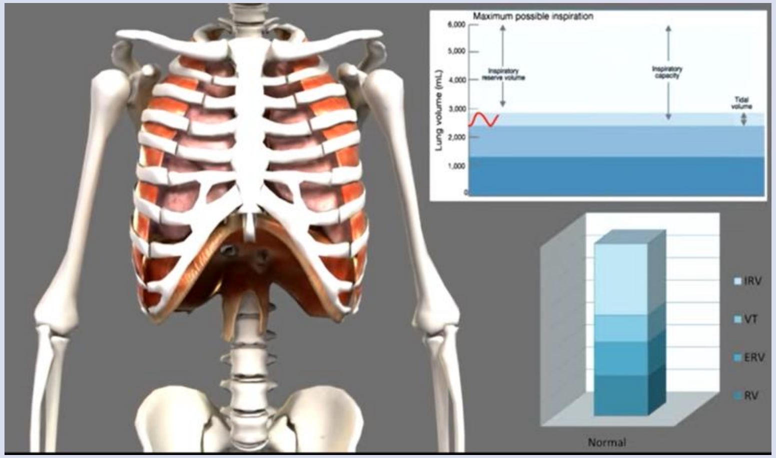
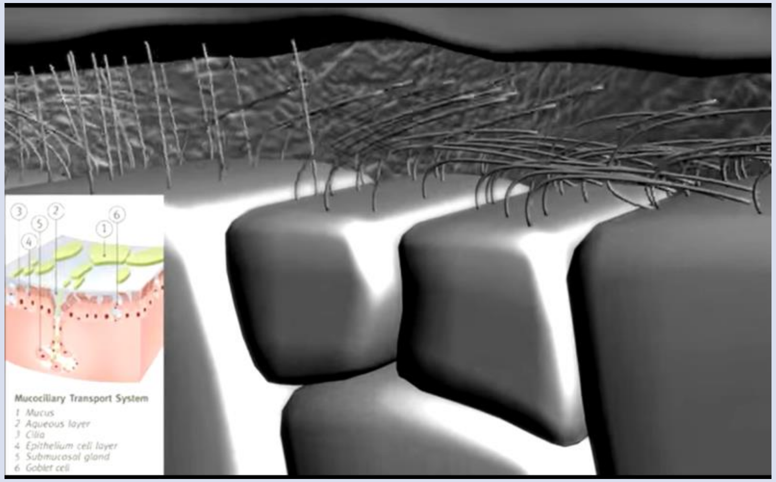
Visualisation was a term that was repeatedly used by students when articulating what was needed to transform their understanding of troublesome topics and concepts within the field of CVR. Students articulated different types of resources that they felt would unlock the blockages to their understanding. Through conversations with students it became apparent that there was a predisposition towards video-based resources with an assumption that these formats, and the content of information within them, would link previously un-connected understanding and perspectives and better enable application to practice and clinical reasoning. The use of video and 3D VR resources to help facilitate understanding of respiratory anatomy, physiology and mechanics was instigated by students, having not been considered by the teaching team before that point.

As a result, several visual and animated resources were created to simulate various physiological and mechanical processes, as well as the use of a patient actor to create an Augmented Reality (AR) resource. These include:

- An interactive resource depicting the ventilation and perfusion distribution in different positions, scenarios and pathologies
- 3D VR videos representing anatomical structures, respiratory mechanics and physiological processes and principles
- Superimposing an AR patient onto the simulated mannikin to provide a verbal history and emulate clinical signs such as increased work of breathing and inability to complete full sentences etc

Table 2.9 provides an overview of the initial problem identified by students, the proposed changes and examples of the resources created with students. These resources were not designed to be stand-alone resources but woven into the teaching sessions themselves and incorporated in discussions and group activities. Ways in which the students engaged with these resources will be explored within Chapters 5 and 7.

Table 2.9 Overview of the simulation, VR and AR resources

Topic	Original L&T approach / resources	Problem identified	Suggested changes	Resource created
Anatomy and physiology teaching	Didactic delivery seminar with questions and activities Use of static diagrams and images Whiteboard use to expand on key theories	Fast paced, unengaging theory, difficult to translate to clinical practice	Dynamic visual content through the use of animation, 3D and video Cilia: https://youtu.be/AA8nqbEzlDw Chest wall movement: https://youtu.be/fzRWW3GPcZ8 Chest wall movement and lung volumes: https://youtu.be/NRiE1uSBnBQ Interactive V/Q resource depicting distribution in different positions/scenarios	 

Patient assessment	Group work to practice techniques such as BP monitoring, auscultation, palpation on peers Use of simulated manikin and case studies to develop real-time clinical assessment and identification of abnormal findings Student example of simulated case scenario: https://youtu.be/63vdCl2uvoY	Group work helped develop practical skills, however, it was difficult to transfer to a clinical situation Simulated case studies didn't feel real. Relatively 'low-tech' so not able to accurately replicate clinical presentation. Limited opportunities for learning and transference to clinical practice	Use of augmented reality video of patient actor provided a summary of symptoms and exhibiting actual clinical signs Augmented Reality video for simulation: https://youtu.be/E0l2qX8r8Zk	

2.3.5 Blended Learning

Blended learning is an educational approach that combines learning technologies with more traditional L&T delivery methods (Berke and Wiseman, 2003). It is described as the effective integration of different learning modalities, technologies and techniques (Finn and Bucceri, 2004 cited by Yigit et al, 2014). It therefore encompasses any and all learning technologies and platforms that could be utilised to support the learning experience. This broad definition avoids the pitfall of dictating specific approaches or technologies but places the onus on the educational provider to select the relevant technology to enhance student learning. It is therefore important to review literature about the efficacy of blended learning to facilitate the judicious selection of applicable learning technologies. This can be found in Chapter 3.

Blended Learning is widely accepted as an umbrella term for the use of technology in education (Hrastinski, 2019). It conveys the model of teaching and range of practices employed to facilitate learning and ensure a high-quality, engaging student experience. Blended Learning requires the employment of active learning strategies and a variety of pedagogical approaches, rich learning materials, synchronous and asynchronous experiences and timely feedback, both on campus and online (Zacharis, 2015; Çakir and Bichelmeyer, 2016).

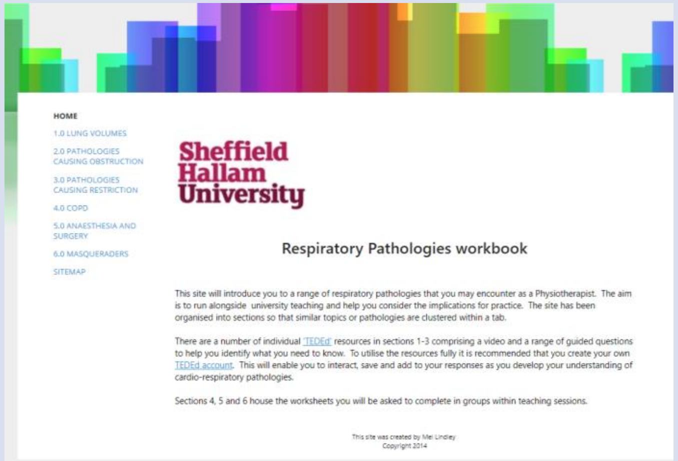
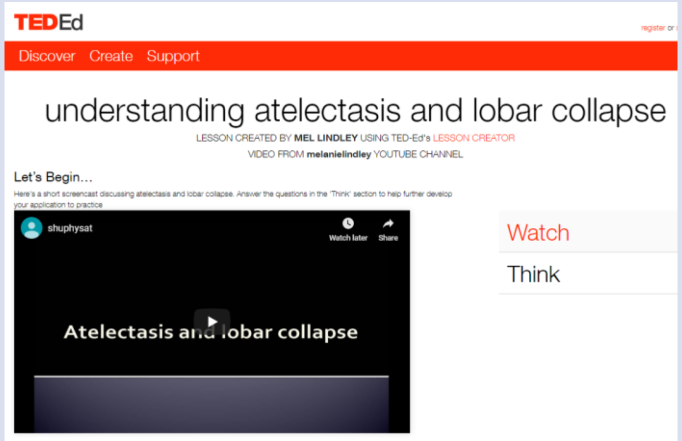
2.3.5.1 Blended Learning Developments Resulting from the Redesign

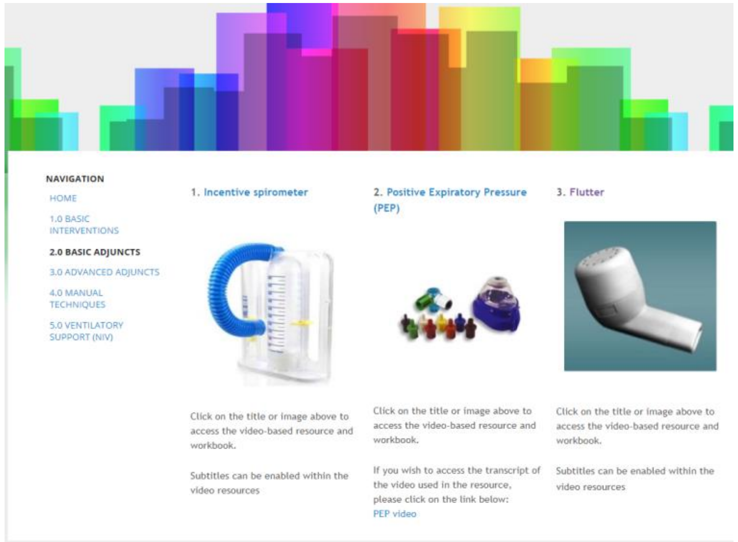
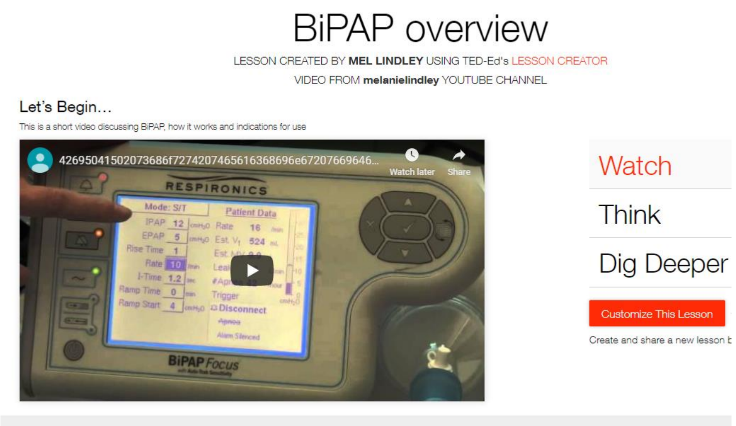
Students re-designing the module indicated an inability to visualise many of the structural, physiological and mechanical changes that occur in CVR pathologies; as well as the various CVR interventions. Students also requested that tutor directed workbooks were redesigned to provide a better balance between tutor directed material and independent study; with the use of video-based material central to this. In the context of the module redesign these blended learning resources were subsequently created for use online prior to, during and after on campus face to face teaching. This is in contrast to the AR, VR and simulation resources that were created for use in-class.

The resources created to support understanding of pathologies were housed in an open access website with a range of screencasts, short answer questions and links to further reading for each pathology. The purpose of this resource was to support in-class activities that focused on linking underpinning pathological and physiological changes to clinical presentation, signs and symptoms; with the aim of improving application and transference of knowledge into clinical practice.

The therapeutic interventions resources followed the same format of using videos, questions and links to additional resources; and utilised the same platforms to optimise familiarity and accessibility. However, the content of the resources was designed differently with each intervention/therapy video consisting of two parts: the first part was an overview of the intervention, mechanisms of action, indications for use and contra-indications; the second part being an example demonstration of how you would explain to teach a patient how to use or perform the intervention. It is the latter aspect of the video that aligns to the social cognitive theory in that it provided a commentary and a model of how to apply the intervention in practice. These resources were not only designed in collaboration with students who agreed key content, but students also created the videos themselves. This was a specific request by students who felt their peers would engage more readily with student-created content. Table 2.10 provides an overview of these resources.

Table 2.10 Overview of the blended learning resources

Topic	Original L&T approach / resources	Problem identified	Suggested changes	Resource created
Respiratory pathologies	Didactic delivery seminar with questions and activities Use of static diagrams and images Whiteboard use to expand on key theories Word-based workbook for students to complete	Difficult to visualise clinical presentation Physiological changes relative to disease progression challenging to understand due to combination of very theoretical resources, too much emphasis on student-led activities and insufficient formative feedback	Integrated online resources that provide explanation and overview, with directed questioning. Opportunities in class to discuss answers to student directed activities https://sites.google.com/a/my.shu.ac.uk/respiratory-pathologies/	 

Treatment techniques and interventi ons	Word-based workbook directing students to explore theoretical underpinnings of techniques and interventions.	Unable to visualise techniques. Difficulty not only grasping techniques, but also limited opportunities to consider how to explain them to patients	Accessible online resource containing video demonstrations of each technique with examples of how they could be explained to patients.	 
	Practical demonstrations in-class with small group work to practice techniques, clinical skills and interventions	No resources to revisit. Feedback provided on clinical skills, not on understanding.	Guided questions to support student directed learning. Opportunities in class to discuss answers to student directed activities. https://sites.google.com/a/my.shu.ac.uk/respiratory-interventions/	

2.4 Summary

Application to clinical practice, the facilitation of clinical reasoning and the desire to improve the learning experience of students in response to their feedback were ultimately the drivers for redesigning the module. What was of importance to the researcher was to understand the impact of the revised L&T approach as well as the role technology in enabling learning. Too often the term 'technology enhanced learning' is used; but enhancement to learning is not guaranteed, nor should the assumption be that it is the technology alone that is improving the learning outcome. It was therefore deemed important to investigate whether the addition of more technology and media-rich resources had an additional effect on learning over and above the redesign and delivery of topics in a more structured and scaffolded way. On exploring the available literature it was clear that there were opportunities to better understand the role 'TEL' and indeed the video/media resources on the development of knowledge, application to practice and clinical reasoning; as well as student experience.

CHAPTER THREE: LITERATURE REVIEW

Fundamental to this study is the development of Clinical Reasoning Skills within CVR Physiotherapy and the learning and teaching means by which to enable that development. As a result of the module redesign that preceded this study, a range of simulation and blended learning activities were proposed. This chapter reviews the body of evidence surrounding the development of clinical reasoning skills in undergraduate physiotherapy programmes; simulation within healthcare education; and blended learning.

The literature reviewed in this chapter represents what was available at the outset of the study. Due to the prolonged nature of this study a further 'bridging' literature review is presented after the results chapter (Chapter 5). This is to ensure the discussion (Chapter 7) situates the study's findings relative to what is known now, demonstrating how this study contributes new knowledge to the current Physiotherapy education landscape.

This chapter is presented in three sections, one per body of literature reviewed. Each of these sections comprises two parts: the first provides a contextual summary; the second a critical appraisal of the body of literature pertinent to this study.

3.1 Clinical Reasoning

As discussed in Chapter 2, clinical reasoning is a term that has been used to define the process of assessment, diagnosis, clinical decision-making, treatment selection and justification, (Higgs et al 2008, Edwards et al, 2004). The concept has evolved over the last 30 years from being predominantly medical and nursing focused, to considering clinical reasoning in the context of physiotherapy professional practice (Elvén and Dean, 2017). Despite much research into clinical reasoning, a lack of shared understanding of clinical reasoning still remains across health and social care (Huhn et al, 2019). This lack of agreement could be influenced by the evolving nature of healthcare practice both in terms of the move away from a medical model towards a more inclusive, activity and participatory focused approach (WHO, 2003), the changing nature of health and social care services and the complex needs of service users.

To understand the evolution of the term clinical reasoning, and its application in the context of Physiotherapy, one should first understand its origins. Much of the medical profession still associates clinical reasoning with diagnostic reasoning, clinical decision making, judgement, and/or medical problem solving (Cooper and Frain, 2017). It is seen as an important component in the delivery of safe and effective care. Ultimately, its primary focus in the medical context is the accurate diagnosis and management of patients.

Deductive Reasoning is the clinical reasoning model that is based upon using rules to guide individuals towards a specific diagnostic conclusion based on whether the information that is presented is congruent with the specific rule; enabling conclusions of true or false to be made (Coderre, Mandin, Harasym, & Fick, 2003). This model has largely been superseded by Hypothetico-deductive reasoning in light of it not accounting for the crudity of some of the initial rules / premises leading to a true or false diagnosis. Inductive reasoning has been described as the process that enables overall conclusions to be made, in the absence of reaching a specific diagnosis and is underpinned by ethical theory (Higgs et al 2008). This model is seen to be of importance in healthcare professions when drawing conclusions based on the available evidence, narrative and social constructs. The conclusions cannot be seen as being absolute, but if reasoned, can be described as cogent.

Abductive reasoning, in contrast, is seen as the process of working backwards from an outcome or diagnosis in order to ascertain cause (Cooper and Frain, 2017; Vertue & Haig, 2008). Again, this does not provide certainty, but draws on the expertise of the clinician using this model of reasoning, based on prior experience and pattern recognition. Other models of reasoning identified include rule-based reasoning, probabilistic reasoning and causal reasoning. Although these are defined in their own right, they offer similarities with some of the aforementioned medical models of clinical reasoning, although they imply a greater level of expertise and autonomy.

Inductive reasoning, with or without hypothetico-deductive reasoning, possibly resonates more with current Physiotherapy models of practice. This is supported by Edwards and Jones (2007) who presented the dialectical nature of reasoning that embraces both inductive and deductive reasoning. More recently, approaches to CVR

Physiotherapy are more likely to follow a participatory, enablement focus in line with the International Classification of Functioning (WHO, 2003) and healthcare policies that place patients at the heart of decision-making about their care. The focus on collaborative goal setting and patient-centred rehabilitation moves the locus of decision-making from being purely clinician-led towards joint decision-making. This approach to practice fundamentally shifts how clinical reasoning can be viewed. Therefore, instead of seeing clinical reasoning as the arrival at a decision as to diagnosis, there have been attempts to identify different strategies used by physiotherapists to inform problem identification and agreed management plan.

Over the last fifteen years there have been many studies exploring clinical reasoning in Physiotherapy (Case, Harrison and Roskell, 2000; Edwards et al, 2004; Higgs, 2008; Ajjawi and Smith, 2010; Cruz, Moore and Cross, 2012). Some have articulated general principles and strategies; others have looked at clinical reasoning in specific settings. What is common across all is the role of the therapist, their beliefs and perspectives; the role of the patient, their beliefs and perceptions; and the influence of context / setting. Higgs, Richardson and Dahlgren (2004) identified eight strategies utilised that support the process of clinical reasoning (Table 3.1).

Table 3.1 Clinical reasoning strategies based on Edwards, Jones and Carr (2004) and Higgs et al (2004)

Strategy	Application
Diagnostic	Processes used to form a physiotherapy diagnosis or identification of patient's problems
Narrative	Processes used to understand client's interpretations of their illness experiences
Procedural	Processes used to make decisions about physiotherapeutic interventions
Interactive	Approaches used to develop, establish and maintain effective interaction
Collaborative	The processes involved in engaging with clients in a mutually agreed interpretation of problems, planning of interventions and decision-making
Teaching	Reasoning about the use of teaching in therapy
Predictive	The processes of identifying the likely progression of a condition and response of the patient to proposed therapy
Ethical	The process of identifying and resolving ethical issues that arise within a given situation

These 8 strategies identified by Higgs et al (2004) take a broad view of clinical reasoning encompassing a range of practices employed by physiotherapists. These strategies incorporate effective communication strategies (narrative; interactive; collaborative) as part of the process, the implication being that communication is fundamental to the clinical reasoning process. Understanding the patient's perspectives and experiences of their illness (narrative) is one of the 8 strategies identified, thereby reinforcing its importance and clearly differentiating it from the diagnostic strategy. This separation of strategies reinforces the ICF (WHO, 2003) premise that personal and environmental factors are explicitly recognised and included.

Elvén and Dean (2017)'s systematic review explored factors affecting clinical reasoning amongst Physiotherapists, reviewing ten qualitative studies, identifying four themes: the physiotherapist; the patient; the process of reasoning itself; and the context in which the process is taking place. Whilst their methodology and process of analysis was concordant with the systematic review process, their justification of their inclusion and exclusion criteria and how they arrived at these ten papers lacked clarity. This resulted in the inclusion of papers that were primarily musculoskeletal / orthopaedic in nature, although wide-ranging in terms of setting and experience. One exception to this was the study based within the acute cardiovascular-respiratory setting.

The variety of papers, and the potential implications for meta synthesis, was not considered within the systematic review. The four main themes of patient, physiotherapist, process and context, whilst helpful, did not fully synthesise the data; rather they clustered evidence under broad themes, categories, sub-themes and second-order findings. The breadth and number of factors are possibly not surprising based on the variety of study contexts and range of expertise of the primary research, coupled with what was already known as contributing to clinical reasoning and decision-making.

Elvén and Dean (2017), Higgs and Jones (2008) and Jones et al (2008) also link the importance of clinical reasoning with evidence-based practice and improved patient outcome. This assertion links factors such as skill acquisition and expertise. When considering the skill acquisition stages outlined in section 2.2.2, the role of the undergraduate physiotherapy programme is to enable students to develop the necessary sills in clinical reasoning to move from novice to advanced practitioner. Understanding the literature pertaining to the development of clinical reasoning skills in undergraduate physiotherapy is therefore of importance.

3.1.1 Review of the Literature Pertaining to the Development of Clinical Reasoning in Undergraduate Physiotherapy Education Programmes

Table 3.2 provides an overview of the search strategy and Table 3.3 the refinement process undertaken to identify the pertinent Clinical Reasoning literature to inform this study.

Table 3.2 Summary of search strategy

Databases searched	ProQuest Central CINAHL MEDLINE/PubMed ProQuest Education Journals Science Direct
Search terms	Subject: Clinical Reasoning AND Physiotherapy OR Physical Therapy
Limits	Language: English Publication date: 1998-2012 Type: articles; peer-reviewed journals
Inclusion criteria	Models of clinical reasoning Education of clinical reasoning CVR Physiotherapy Specialism
Exclusion criteria	Inter-professional education Condition/context-specific (non-CVR) Advanced Practice Post-graduate

Table 3. 3 Refinement process to enable identification of pertinent clinical reasoning literature

Number of articles generated	330
Number after inclusion-exclusion criteria applied	88
Number after abstracts reviewed	24
Number after full texts reviewed	18
Number pertaining to models of clinical reasoning in Physio +/- CVR	11
Number pertaining to developing clinical reasoning in UG Physiotherapy education programmes	8

The basis of the literature analysis uses the MMAT critical appraisal, enabling the review of different methodological studies (Hong et al, 2018). The MMAT focuses on 5 key questions, adapted relative to methodology type. Each methodology has the same initial screening questions which are: are there clear research questions; and do the collected data allow to address the research questions. There then follows a series of 5 questions pertinent to the study's chosen methodology to aid in the assessment of methodological rigour. Details of the MMAT Tool can be found in Appendix 1.

Eight papers were identified as a result of the refinement process indicated in Table 3.3 pertaining to developing clinical reasoning in UG Physiotherapy education programmes. A summary of these papers can be found in Table 3.4. A critical appraisal summary of each paper can be found in Appendix 2.

Table 3. 4 Summary of papers pertaining to the development of clinical reasoning in Physiotherapy education programmes

Study	**Design**	**Participants**	**Analysis**	**Findings and strength of findings relative to methodology (finding from + to + + +)**
Type of study: Quantitative non-randomised				
Keiller, L., Hanekom, S.D., (2014) *Strategies to increase clinical reasoning and critical thinking in Physiotherapy Education*	Pre-post interven tion	38 UG Students	Diagnostic Thinking Inventory, Self-assessment Clinical Reflections and Reasoning (SACRR) measure	Strength of findings: + The use of concept maps had no impact on the development of clinical reasoning and critical thinking. However, the use of Problem-based learning was of significance
Type of study: Consensus				
Sole, G., Skinner, M., Hale, L., Golding, C. (2019) *Developing a framework for teaching clinical reasoning skills to undergraduate physiotherapy students*	Delphi	41 Staff	Thematic analysis of free text answers in round 1 to identify statements for subsequent rounds. Five-point Likert score used. Results from round 2 sent with round 3 to enable re-scoring of statements	Strength: + + Framework consisted of 8 elements to be articulated: CR definition; Process Personal attributes Models of CR; Components; Patient-related factors; Physio-related factors; Other factors/sources
Type of study: Qualitative				
Babyar, S.R., Rosen,E , Macht. Sliwinski M, Krasilovsky, G Holland, T. Lipovac, M (2003) *Physical Therapy Students' Self-Reports of Development of Clinical Reasoning.*	Survey	156 (22%)	Analysis of free-text answers (process unclear)	Strength of findings: + Students place an emphasis on needing a balance between clinical placement learning and classroom teaching Written case studies useful to develop CR Even spread of learners across Kolb's learning styles

Study	Design	Participants	Analysis	Findings and strength of findings relative to methodology (finding from + to + + +)
Type of study: Qualitative				
Cruz, E.B., Moore, A.P., Cross, V. (2012) *A qualitative study of physiotherapy final year undergraduate students' perceptions of clinical reasoning.*	Focus Groups	24	Interpretive hermeneutics Process of data analysis described Member checked/peer reviewed	Strength of findings: + + 4 main themes: CR is an instrumental process to develop theoretical knowledge and technical skills CR is a clinician-centred process CR is a knowledge-dependent process CR is context dependent
Furze, J., Black, L., Hoffman, J., Barr, J.B., Cochran, TM., Jensen, G.M.(2015) *Exploration of Students' Clinical Reasoning Development in Professional Physical Therapy Education.*	Longitu dinal question naire	98	Analysis of comments from clinical supervisors within clinical performance instrument plus self-assessment Clinical Reasoning Reflection Questionnaire (not validated)	Strength of findings: + 3 stages of CR development: Focus on self initially, compartmentalise, limited acceptance of response to situation Starting to recognise context; procedural; improved reflection on performance Dynamic pt interaction; situational awareness
Type of study: Qualitative				
Gillardon, P., Pinto Zipp, G. (2002) *A proposed strategy to facilitate clinical decision making in physical therapist students.*	Longitu dinal, question naire	25	Questionnaire evaluating student scoring of algorithm (not validated)	Strength of findings: - Average score 3.7 (out of 5) regarding the value of the algorithm in facilitating clinical decision making

Study	Design	Participants	Analysis	Findings and strength of findings relative to methodology (finding from + to + + +)
Type of study: Qualitative				
Gilliland, S. (2014) *Clinical Reasoning in First- and Third-Year Physical Therapist Students.*	Observation and analysis of verbal commentary	18	Verbal commentary, assessed against a framework and ICF domains Follow-up interview – thematic analysis	Strength of findings: + + Hierarchy of sophistication yr1 vs yr3: yr 3 students demonstrated better clinical reasoning Yr 1 students tended towards: trial and error, following protocol and rule in and out. Whereas Yr 3 students tended towards hypothetico-deductive and pattern recognition.
Gilliland, S., Flannery Wainwright, S. (2017) *Patterns of Clinical Reasoning in Physical Therapist Students.*	Case study	8	Video and audio recording of standardised patient encounter Thematic analysis	Strength of findings: + + Those demonstrating greater attention to physiotherapy education and empowerment of patients also demonstrated greater use of reflection in-action. Students demonstrated different approaches to the clinical encounter

Of the eight studies reviewed, six were qualitative; one quantitative non-randomised and one was a Delphi study. Babyar et al (2003) and Cruz et al (2012) both investigated student perspectives of clinical reasoning, whilst Furze et al (2015), Gilliland (2014), Gilliland and Flannery-Wainwright (2017), and Keiller and Hamekon (2014) assessed the clinical reasoning skills demonstrated by students. Gillardon and Pinto (2002) outlined a framework for teaching clinical reasoning with Terry and Higgs (1993) describing considerations for academics when designing the teaching of clinical reasoning. Sole et al (2019) undertook a Delphi study to gain consensus from academics and clinical educators in the development of clinical reasoning skills.

Those studies that explored students' perceptions, Babyar et al (2003) undertook a survey while Cruz et al (2012) used focus groups. The focus of the Babyar et al (2003) study was to ascertain what educational approaches students felt most beneficial in developing their clinical reasoning, while Cruz et al (2012) asked students to explain their approach to clinical reasoning in a particular setting. Cruz et al (2012) identified four main themes in how students approached clinical reasoning: clinical reasoning is an instrumental process to develop theoretical knowledge and technical skills; clinical reasoning is a clinician-centred process; clinical reasoning is a knowledge-dependent process; and clinical reasoning is content dependent. The study highlighted the challenges in teaching clinical reasoning reporting that participants perceived clinical reasoning to be very process and theoretically driven, identifying the need to better emulate the more inclusive and participatory principles of the ICF within their physiotherapy programmes. The study demonstrated rigor in the data analysis process through the use of member checking and peer review.

Babyar et al (2003) created a questionnaire with both free text questions and a rating scale to ascertain student perspectives. Authors concluded that, whilst there is a need for both classroom teaching and placement learning to develop clinical reasoning, students placed greatest importance on placement and the use of case studies to develop their clinical reasoning. Whilst there was a large sample-size, response rates were only 22% of those surveyed and there were no details of the questions asked, evidence of validation of the questionnaire or detail of how the free-text answers were analysed. The generalisability of their conclusions should therefore be viewed with caution.

Of the five qualitative studies, Furze et al (2015) undertook a longitudinal observation of the development of clinical reasoning of undergraduate students, whilst Gilliland (2014) compared Year 1 students with Year 3 students. Gilliland and Flannery-Wainwright (2017) observed patterns of clinical reasoning in 2nd Year students. Keiller and Hanekom, (2014) investigated methods to improve clinical reasoning and the inclusion of concept mapping. Gilliland (2014) identified a hierarchy of sophistication from year 1 students to year 3 students, with year 3 students demonstrating better clinical reasoning. Year 1 students were found to tend towards trial and error, and the following of protocols. This is in keeping with Higgs et al., (2008) model of skill acquisition and the differences between Novice practitioners and Advanced Beginners.

Gilliland and Flannery-Wainwright (2017) found that for a standardised clinical scenario, students demonstrated a broad range of approaches to clinical reasoning, although possible reasons for this were not explored. They identified that students who followed an empowerment model were more likely to demonstrate reflection in-action, although their process of analysis enabling the drawing this conclusion is not clear. Each of the studies expressed different aims and used different methods of data collection and analysis, ranging from verbal commentary to validated questionnaires. The provides a broader insight into clinical reasoning approaches employed in undergraduate physiotherapy programmes but makes comparison or meta inference more challenging.

Gillardon and Pinto (2002) provided a framework/algorithm for guiding student clinical decision-making embedded within their UG programme. They investigated student perceptions of the tool and its impact on their clinical decision-making via a questionnaire. This study provided little detail of the process of developing the algorithm prior to the study, so it is not possible to frame the decision-making tool in relation to known models and strategies for clinical reasoning. It is also difficult to draw conclusions as to its relevance and transferability beyond the study itself. Furthermore, the validity of the questionnaire tool was not discussed.

Sole et al (2019) undertook a Delphi study to gain consensus from academics and clinicians in the teaching of clinical reasoning. A framework was developed identifying 8 core elements that needed to be incorporated/considered in the development of undergraduate clinical reasoning skills. These were: define what is meant by clinical reasoning; outline the process of clinical reasoning; consider personal attributes; explore models of clinical reasoning; consider components of clinical reasoning; patient related factors; physiotherapy related factors; other factors/sources. Whilst the Delphi process was clearly stated, the first stage of generating themes did not clearly align to the study aims. In addition, what is not clear is how this framework should be used and what it adds to the current literature. Whilst these core elements have face validity, they do not necessarily aid the design of undergraduate physiotherapy curricula.

Despite the large variation in methodologies, some common themes did emerge, namely the formulaic and protocol/process driven approach seen in novice practitioners. A hierarchy of sophistication relative to study progression was noted by Gilliland's (2014) when comparing 1st and 3rd year undergraduate physiotherapy students. Furze et al's (2015) longitudinal study highlighted the progression from compartmentalised and formulaic approaches to clinical reasoning to recognising context and greater situational awareness as students progressed throughout their educational programme. Ultimately, whist there are many different frameworks and models of clinical reasoning that support the professions' shift towards a holistic, person-centred approach, the challenge remains for educational programmes to facilitate such an approach during the early stages of undergraduate studies.

3.2 Simulation

This section provides an overarching summary of simulation within healthcare education at the time of study commencement; section 3.2.1 provides a critical appraisal the literature at that time. The supporting educational theory for the use of virtual and simulated environments often refers to Social Cognitive Theory, Constructivism, Experiential Learning, deliberative practice and the mental model (Heinrich et al, 2012; Burke and Mancuso, 2012). Key to the effectiveness of simulation as a means of healthcare education is the design of the simulated scenario (Jeffries and Rizzolo, 2006), including clear learning objectives, realism, real-time participation, facilitation and reflection (Shoemaker, Reimersma and Perkins, 2009).

Much of the early literature surrounding the use of high-fidelity simulation provided narrative and case examples to support large-scale implementation within healthcare education programmes (Good, 2003; Bradley, 2006; Cannon-Diehl, 2009; Harder, 2009; Kneebone, 2010; Khan, Pattison and Sherwood, 2011). Within medical education it was reported to support the development of accurate clinical intervention skills through repetition and gradual advancement in complexity of task, alongside measurement and formative feedback. The implication is that simulation in the medical education context facilitated the acquisition of technical skill and clinical ability (McGaghie et al, 2006; Cook et al 2011).

Nursing studies have shown that simulation impacts positively on knowledge, skills, and behaviours; as well as contributing positively to patient-related outcomes (Gates, Parr and Hughen, 2012; Shinnick, Woo, Evangelista, 2012). However, Brewer (2011) reviewed the findings from the different simulation techniques and approaches taken within nursing education and found that, while there was increasing use across the sector, the studies were qualitative in nature, with a paucity of robust research to validate many of the assertions.

The role of facilitated reflection and debrief was identified as a core component of simulation in order to further the learning experience and enable students to develop their learning outside of specific simulated environments (Fanning and Gaba, 2007; Shinnick et al, 2011; Neill and Wotton, 2011). The facilitated debrief is designed to guide students through a structured reflection of the simulated scenario they have either participated in or observed, to facilitate enhancements to learning (Schinnick et al, 2011). A varied approach to debrief was documented at the time (Brackenreg, 2004; Kuiper et al 2008); and whilst examples of effective debrief practice do currently exist, these are usually confined to smaller cohorts and involve significant time allocated specifically for debrief (Neill and Wotton, 2011). Both simulated practice and debrief were thought to provide meaningful ways in which healthcare students could learn, although it has been deemed costly both in terms of infrastructure and facilities required, as well as staffing costs to effectively delivery quality simulation and debrief (Shinnick, Woo and Evangelista, 2012). Achieving this on scale with large UG cohorts in a cost-effective manner can therefore present a challenge to HEIs.

3.2.1 Review of Simulation Literature Prior to the Study

The development of clinical reasoning and decision-making in the context of the CVR Physiotherapy and facilitating the advancement beyond novice practitioner were primary drivers for the redesign of the module. It was therefore important to identify and appraise relevant literature. A detailed search of the literature for experimental/quasi-experimental simulation within healthcare and/or Physiotherapy education research was conducted as outlined in Table 3.5.

A summary of the 9 papers selected for review can be found in Table 3.7 with an MMAT critical appraisal summary provided in Appendix 3. Of the studies selected, five were quasi-experimental, two were systematic literature reviews, one was a feasibility/pilot study and one was a descriptive account of developing simulation within an UG Physiotherapy programme.

Table 3. 5 Search strategy for the identification of possible relevant simulation literature

Databases searched	ProQuest Central MEDLINE/PubMed ProQuest Education Journals Science Direct
Search terms	Subject: Simulation/Simulations* AND Healthcare Education OR Physiotherapy/Physical Therapy* Education
Limits	Language: English Publication date: 1998-2012 Type: articles; peer-reviewed journals
Inclusion criteria	Undergraduate Available online Higher Education setting Physiotherapy* Education Nursing* Education Medical * Education Cardiovascular-respiratory specialism Experimental, quasi-experimental, systematic review, case example
Exclusion criteria	Behaviours (e.g. risk taking, communication) Specific skill acquisition / non-cardiovascular-respiratory specialism (e.g. venopuncture, obstetrics) Interprofessional education Computer-based

Table 3. 6 Refinement process to enable identification of pertinent simulation literature

Number articles generated	210
Duplicates removed	12
Number after exclusion criteria applied to Title	48
Number after exclusion criteria applied to Abstract	16
Number after exclusion criteria applied to Full Text	9

Table 3. 7 Summary of Simulation papers

Study	**Design**	**Participants**	**Analysis**	**Findings and strength of findings relative to methodology (finding from + to + + +)**
Type of study: Systematic Review				
Harder, N.B. (2010) Use of Simulation in Teaching and Learning in Health Sciences: A Systematic Review	SR	No of studies with the following participants 13 UG 10 staff	Process of analysis: Not stated	Strength of findings: Knowledge:+ Self-assessment: +
Laschinger S., Medves J., Pulling C, McGraw R., Waytuck B., Harrison M.B., Gambeta K (2008) Effectiveness of simulation on health profession students' knowledge, skills, confidence and satisfaction	SR	23 UG	2 independent reviewers Standardised data extraction tool utilised	Strength of findings: Knowledge + Clinical reasoning: + Self-assessment: + Experience/ perceptions: +
Type of study: Quantitative				
Alinier, G (2003) Nursing students' and lecturers' perspectives of objective structured clinical examination incorporating simulation	Post-test	86 UG 39 Staff	Post-test questionnaire	Strength of findings: Self-assessment: + Experience/ perceptions: +
Heinrich, C., Pennington, R.R., Kuiper, R. (2012) Virtual Case Studies in the Classroom Improve Student Knowledge	Pre-test, post-test	56 UG	MCQ Satisfaction questionnaire (adapted, not validated)	Strength of findings: Knowledge: ++ Clinical reasoning: ++ Experience/ perceptions: +

Type of study: Quantitative				
Ladyshewsky, R., Baker, R., Jones, M., Nelson, L. (2000) Evaluating clinical performance in physical therapy with simulated patients	Post-test	12 UG 4 PG (acting as a control	Standardised assessment tool (validated as part of study)	Strength of findings: Knowledge: ++ Clinical reasoning: ++ Experience/ perceptions: +
Type of study: Qualitative				
Corrigan, R., Hardham, G. Cant,R; Mort,J R. (2011) Use of technology to enhance student self-evaluation and the value of feedback on teaching	evaluation	60 UG	Thematic analysis of open-ended questionnaire	Strength of findings: Self-assessment: + Experience/ perceptions: +
Shoemaker M.J., Riemersma L., Perkins R., (2009) Use of High Fidelity Human Simulation to Teach Physical Therapist Decision-Making Skills for the Intensive Care Setting	Case description	NR	Questionnaire (not validated) Informal comments (no detail of analysis)	Strength of findings: Self-assessment: + Experience/ perceptions: +
Type of study: Mixed Methods				
Howard, V.M.,Englert, N., Kameg, K., Perozzi, K. (2011) Integration of Simulation Across the Undergraduate Curriculum: Student and Faculty Perspectives		15 UG 6 Staff	Questionnaire 5-point Likert scale (students) Focus groups (staff)	Strength of findings: Self-assessment: + Experience/ perceptions: +
Traynor M, Gallagher A., Martin L., Smyth S. (2010) From novice to expert: using simulators to enhance practical skill	Post test	156	23 item Questionnaire 5-point Likert plus open ended questions (not validated)	Strength of findings: Experience/ perceptions: +++

All five quasi-experimental studies evaluated the students experience through the use of questionnaires (Alinier, 2003; Corrigan et al., 2011; Heinrich, Pennigton and Kuiper, 2012; Howard, Englert, Kameg and Perozzi, 2011; Traynor, Gallagher, Martin, and Smyth, 2010). Of these studies, three utilised a 5-point Likert scale for their student questionnaire, with only Corrigan et al., (2011) and Alinier (2003) electing to use other means and/or scales to gauge student feedback. Students were asked to comment on the learning experience itself and their perception of the impact simulated learning had on their levels of competence/clinical practice. All studies reported a positive student experience and an improved level of confidence in their abilities. Many of these studies provided simulated learning as a voluntary addition (Alinier, 2003; Corrigan et al., 2011; Heinrich, Pennigton and Kuiper, 2012; Gallagher, Martin and Smyth, 2010) or as an additional formative activity (Howard, Englert, Kameg and Perozzi, 2011; Ladyshewsky, Baker, Jones and Neilson, 2000). It was therefore only possible to ascertain supplementary learning, without insight into what might be the most efficacious L&T approach. Furthermore, it could be argued that those students motivated to attend additional learning opportunities were possibly more likely to be engaged with their professional development. It is therefore not possible from these studies to draw widespread conclusions as to the impact of simulated learning on a whole cohort of students.

Due to the heterogenous nature of the studies selected, meta-analysis was not possible. However, common findings worthy of note include a positive impact on self-assessment of ability of those students who undertook simulated activity in six of the studies (Howard et al., 2011; Shoemaker, Riemersma and Perkins, 2009; Corrigan et al., 2011; Alinier, 2003; Laschinger et al 2008; Harder, 2010). Of the studies who assessed students' perceptions of their ability as a result of simulation, very few triangulated these results with any quantifiable assessment carried out by clinicians or educators. Therefore, whilst it can be seen that those students who elected to undertake additional simulated learning felt it was of benefit and improved their clinical ability, there is no way to substantiate whether this translated into clinical practice.

Laschinger et al., (2008) Heinrich, Pennington, and Kuiper (2012); and Ladyshewsky, et al (2000) were the only studies who reported clinical reasoning and/or critical thinking outcomes. The systematic review carried out by Laschinger et al., (2008) analysed 23 papers finding mixed reports as to the impact of skills acquisition and clinical reasoning. The challenge for these reviewers was drawing robust conclusions from such a range of studies, methodologies, and outcome measures. Relevant to the context of the CVR module, and indeed the area of acute respiratory medicine were the questions raised by the authors as to simulation's ability to enable a student to cope in a previously unwitnessed emergency.

Whilst the case studies used in the module for the simulated activities would not be classed as an emergency, many were written to present as deteriorating clinically and requiring intervention.

3.3 Blended Learning

Blended learning is an educational approach that combines learning technologies with more traditional L&T delivery methods (Berke and Wiseman, 2003). It is described as the effective integration of different learning modalities, technologies and techniques to meet the required learning objectives (Finn and Bucceri, 2004). It therefore encompasses any and all learning technologies and platforms that could be utilised to support the learning experience. This broad definition avoids the pitfall of dictating specific approaches or technologies but places the onus on the educational provider to select the relevant technology to enhance student learning.

Blended Learning is widely accepted as an umbrella term for the use of technology in education (Hrastinski, 2019). It conveys the model of teaching and range of practices employed to facilitate learning and ensure a high-quality, engaging student experience. Blended Learning requires the employment of active learning strategies and a variety of pedagogical approaches, rich learning materials, synchronous and asynchronous experiences and timely feedback, both on campus and online (Zacharis, 2015; Çakir and Bichelmeyer, 2016).

A review the literature about the efficacy of blended learning may therefore facilitate the judicious selection of applicable learning technologies.

3.3.1 Review of the Blended Learning Literature Prior To The Study

Studies in relation to blended learning have often investigated the experiences of students in relation to utilising e-learning/online resources (Dietz-Uhler & Hurn, 2013; Ryder et al, 2015). Indeed, much of the focus of evaluating the impact of TEL has been in relation to the technology used, not the educational design (Kirkwood & Price, 2014). Fewer studies still have investigated or demonstrated improved academic outcome or the development of clinical reasoning skills as a result of using such technologies. Table 3.8 and 3.9 identify the search strategies and refinement criteria used to identify pertinent literature

Table 3. 8 Search strategy for the identification of possible relevant Blended Learning literature

Databases searched	ProQuest Central MEDLINE/PubMed ProQuest Education Journals Science Direct
Search terms	Subject: Blended Learning OR E-learning AND Healthcare Education OR Physiotherapy/Physical Therapy* Education
Limits	Language: English Publication date: 2006-2012 Type: articles; peer-reviewed journals
Inclusion criteria	Undergraduate Available online Higher Education setting Physiotherapy* Education Nursing* Education Medical * Education Experimental, quasi-experimental, systematic review, case example
Exclusion criteria	Simulation Purely online / distance learning Interprofessional Editorial / Opinion

Table 3. 9 Refinement process to enable identification of pertinent Blended Learning literature

Number articles generated	72
Duplicates removed	2
Number after exclusion criteria applied to Title	18
Number after exclusion criteria applied to Abstract	9
Number after exclusion criteria applied to Full Text	6

Six studies investigating the impact of blended learning in healthcare education were reviewed. A summary can be found in Table 3.10, with the MMAT Appraisal summary located in Appendix 4.

Table 3. 10 Summary of Blended Learning Papers

Study	Design	Participants	Analysis	Findings and strength of findings relative to methodology (finding from + to + + +)
Type of study: Mixed Methods				
Moeller, S; Spitzer, K; Spreckelsen, C, (2010) *How to configure blended problem-based learning Results of a randomized trial:*	Randomised MM	237 (17 interview)	Questionnaire, self-test, self-assessment, structured interviews Non-para inferential testing of likert data No info re: analysis of data generated within interviews	Strength of findings: + + No difference between synchronous and asynchronous learning in self-test Students felt asynchronous communication best facilitated learning Self-assessment increased most following the use of wiki case study discussions
Type of study: Qualitative				
Shah, I M ; Walters, M R ; McKillop, J H, (2008) *Acute medicine teaching in an undergraduate medical curriculum: a blended learning approach*	Evaluation	99	Descriptive statistics based on Likert scale responses	Strength of findings: + Positive student experience Increased student confidence in the management of patients Seen as a supplement to f2f Not suitable for all topics – more challenging topics required f2f discussion
Rigby, L; Wilson, I; Baker, J; Walton, T; Price, O; Dunne, K; Keeley, P (2012) *The development and evaluation of a 'blended' enquiry based learning model for mental health nursing students: "making your experience count"*	Focus group	27	Thematic analysis	Strength of findings: + + Students were able to apply an ethical model to practices Blended learning facilitates independent learning Improvement in in IT skills

Study	**Design**	**Participants**	**Analysis**	**Findings and strength of findings relative to methodology (finding from - - - to + +)**
Type of study: Quantitative				
Davidson, (2011) *A 3-year experience implementing blended TBL: Active instructional methods can shift student attitudes to learning*	Evaluation	3x100	Two-tailed t-test	Strength of findings: + Gradual increase in perceptions of blended (online) learning value over time
Wakefield, A,B Carlisle, C; Hall, A G; Attree, M J (2008) *The expectations and experiences of blended learning approaches to patient safety education*	Pre and post intervention Focus groups and individual interviews	12 (Int) 16 (FG) 18 staff (FG)	Content analysis	Strength of findings: + Poor engagement with flipped learning model IT access proved problematic for some
Croker, K; Andersson, H; Lush, D; Prince, R; Gomez, S (2010) *Enhancing the student experience of laboratory practicals through digital video guides*	Post-test questionnair e	74	Descriptive statistics (dichotomous answers to questionnaire). Review of free text	Strength of findings: + + Videos preferable to printed workbooks 50% used the resource as flipped learning Encouraged attendance in f2f Supported social learning

Shah, Walters and McKillop (2008), and Moeller, Stizer and Speckelsen (2010) both investigated blended learning to facilitate problem-based learning in undergraduate medical educational programmes, although the approaches taken by the respective research teams differed. Moeller, Stizer and Speckelsen (2010) undertook a mixed methods study ascertaining the difference between synchronous and asynchronous approaches to facilitating problem-based learning, measuring student experience and a self-assessment. Similarly, Shah, Walters and McKillop (2008) used blended learning within problem-based learning, using questionnaires to ascertain student feedback on the experience. Both indicated that students felt there was benefit to using this approach, although there was no measurement of student attainment to substantiate self-assessment assertions. These studies provided insight into participants' level of confidence in their knowledge of the subjects covered online, but did not provide insight into the outcome of online teaching methods used or the students' levels of competence as a result. This lack of comparison between assessed and self-assessed marks leaves ongoing uncertainty as to the impact blended learning has on student outcomes.

Wakefield et al, (2008) and Rigby et al, (2012) both explored the experiences of nursing students undertaking a blended learning module. Wakefield et al, (2008) showed mixed engagement with many participants indicating that they were unaware of the online resources and their purpose. The small number of participants who did access the resources in this study did, however, indicate that they were extremely useful. Rigby et al., (2012) identified that student nurses were able to transfer the learning for the blended approach to practice. Feedback from participants about teachers assuming levels of digital capability and flexibility of access were key learning points from Wakefield et al., (2008) with Rigby et al. (2012) indicating students felt their IT skills developed as a result of engaging with blended learning approaches.

Of particular relevance to the context of this thesis, Croker et al (2010) developed video-based guides to support the development of practical skills and enhance the student experience. The aim was to improve students' preparation for their practical teaching prior to the classroom-based activities. This study enrolled 74 participants and gained feedback in relation to the quality of the resources produced, how and when they were accessed and utilised as well as their perceived value. Whilst the method of analysis employed within this study is unclear, the authors reported that students felt videos were preferable to printed workbooks, that they were often used in advance of class and encouraged face to face attendance. The production quality of the videos was reported as not being important to the students.

At the time of study commencement limited literature was available as to the use of blended learning within healthcare education; and what was available focused predominantly on student experience and self-assessment. This provided valuable insights into the experiences and study patterns of students within these studies. However, there was little available evidence as to the impact of blended learning on student learning or skill acquisition. Whilst the experiences of students and the value placed on their education is of importance, so too is the impact changes in the curriculum have on knowledge, understanding and skill development.

In the context of this study it was important to the researcher to ascertain whether the blended learning and video-based resources impacted positively not only on the student experience, but their actual learning and transference into clinical practice.

3.4 Chapter Summary

Clinical Reasoning is fundamental to the practice of a Physiotherapist and is a skill that develops through learning, increased clinical experience and reflection (Jones, Jensen, & Edwards, 2008), with the strategies employed as part of the clinical reasoning process changing relative to the context (Cruz, Moore, & Cross, 2012). Physiotherapy education programmes need to equip graduates with the necessary skills to be able to adapt their approach and strategy relative to the clinical situation (Higgs, Jones, Loftus, & Christensen, 2008). Redesigning the UG curriculum to include both simulation and blended learning was the precursor to this study. The literature reviewed in this chapter has provided insight into the use of simulation and blended learning approaches in UG healthcare programmes, summarising the evidence-base at the time of study commencement.

Whilst the literature supports the decisions made in relation to the learning technology choices made, the available body of research was not sufficiently extensive to inform the potential impact across student outcomes, self-efficacy and student experience. Questions remain as to whether simulation improves not only knowledge and understanding, but transference of that knowledge and understanding to clinical practice for novice undergraduates. The evidence for blended learning supports a positive learning experience, although little research assessed the impact on student knowledge, understanding or skill. It is apparent that assessing student experiences and perceived learning alone does not provide a full understanding of its educational value. The contradictory evidence on the impact of simulation on the development of clinical reasoning, alongside the paucity of blended learning literature investigating the outcome on knowledge and understanding, provide a basis for further study.

3.5 Research Aims and Objectives

Based on the foregoing review of relevant literature, the primary aim of this research is to investigate the impact of the curriculum redesign and inclusion of learning technologies. The specific objectives regarding impacts and outcomes are:

- To assess the impact on student knowledge, understanding and clinical reasoning in the field of cardiovascular-respiratory physiotherapy.
- To explore the impact on student self-assessment of knowledge, understanding and competence in the field of cardio-respiratory Physiotherapy assessment and treatment.
- To gain insights into the perceptions of Physiotherapy students in relation to the different L&T approaches and technologies utilised.

The main research questions can be summarised as follows:

1. Does the inclusion of learning technologies and video-based resources have a greater impact on knowledge and understanding than traditional teaching methods?
2. Does the module redesign improve students' Clinical Reasoning in the field of CVR Physiotherapy?
3. Does the inclusion of learning technologies and video-based resources impact positively on student's perceptions of clinical ability when compared to traditional teaching methods?
4. What learning and teaching approaches had the greatest impact on the student experience?

CHAPTER FOUR: METHODOLOGY

This chapter seeks to describe and justify the methodology employed within this study: from overarching research philosophies to paradigms and methodologies, implementation and techniques used for data analysis. Section 4.1 of this chapter provides an overview of philosophical research perspectives; with section 4.2. outlining a range of paradigms and methodologies of relevance. Section 4.3 details the chosen methodological approach and discusses the positionality of the researcher. Section 4.4 describes the research methods deployed within the module in which this study is situated. The sampling strategy is provided in section 4.5, with consideration of variables and means to ensure methodological rigour discussed within section 4.6. Ethics and consent are explored in section 4.7. The range of outcome measures used are presented and justified within section 4.8. Section 4.9 introduces the qualitative analysis process used within the study.

4.1 Research Philosophical Perspectives

Ontology concerns the identification of what is known (Teddlie and Tashakkori, 2009), whereas Epistemology relates to the nature of how something is known and what kinds of knowledge is possible (Ritchie and Lewis, 2003). Positivism is concerned with the collection of empirical data and observations through controlled means that test hypotheses and provide identification and verification of information (Khanna, 2019). Conversely, Constructivism is concerned with how an individual constructs and makes sense of the world around them (Creswell and Plano Clark, 2011).

Post-positivism is situated at the relativism end of the spectrum, asserting that whilst there is, in theory, an external reality there are multiple interpretations of that reality, based on factors such as experience, perspective and environment, each of value to those who hold the belief of that reality (Creswell and Plano Clark, 2011). Interpretivism aligns to relativism believing that a single phenomenon may have multiple interpretations; and the study of which provides a deeper understanding relative to context. Interpretivism does not attempt to generalise to a wider population, but rather to understand the multiple interpretations that exist across individuals.

4.2 Research Paradigms and Methodologies

4.2.1 Positivism, Post-Positivism and Interpretivism

In order to design and implement quality educational research that demonstrates impact and that can be accessible and meaningful to students, practitioners and commissioners alike, a balance needs to be struck between the underpinning philosophies, their respective paradigms and the most appropriate methodology for the context of the study. Whilst an epistemological stance of understanding how knowledge is constructed is undoubtedly of relevance in the wider educational context, it was the more ontological stance that drove much of the methodological choices within this study.

Positivists deem randomised controlled trials (RCTs) the gold standard of research methodologies as a means of testing the null hypothesis and ascertaining whether an intervention works, or a theory has been proven (Beutler, Forrester and Shahar, 2014). This perspective, however, has been questioned, particularly by social science researchers, who consider personal, social, cultural and environmental factors as important influences on how we as individuals interpret these 'facts' and create meaning (Nicholls, 2018; Beutler, Forrester and Shahar, 2014).

Post-positivism is concerned with realism but takes both a deductive and inductive stance (Racher & Robinson, 2003). Post-positivism is said to be underpinned by critical realism and aligns to both quantitative and qualitative methodologies, depending on the context of the research. Post-positivist qualitative studies facilitate the gaining of insight and understanding of multiple and differing perspectives; whilst also attempting to offer clarity and sufficient agreement amongst participants that enables judgments to be formed and recommendations to be made.

Interpretivism aligns to methodologies that provide a narrative through an inductive approach and the co-construction of data (O'Reilly, 2008). It also strongly integrates reflexivity by encouraging the researcher to explore their own influences on the research process through socio-psychological dialogue and reflexive elaboration. This research paradigm is of real importance in giving voice to individuals without interpretation of ideas and perspectives. This approach and co-construction of data and individual narrative would not have enabled the research questions to have been answered and hence a constructivist approach to the study was not followed.

4.2.2 Pragmatism and Real-World Research

There has been some debate as to whether and how the paradigm should drive methodological decisions (Wolgemuth, 2016). Pragmatism and Real-World Research are relevant to this debate. The Pragmatism paradigm relates to the drive to investigate what is important to the researcher and the anticipated consequences (Teddlie and Tashakkori, 2009); with Pragmatists identifying methodologies that align to their values and are most likely to yield interesting results (Tashakkori and Teddlie, 2010).

Real-world research is concerned with practical problems or issues that are grounded in a specific context. It is widely recognised as occurring in arenas that are concerned with social research methods and that are 'people-focused', such as healthcare, education or business (Robson and McCartan, 2016). Real-world research asserts that constraining all variables and identifying a specific outcome relative to one intervention, whist important within several spheres of empirical research, does not always provide a true picture in a given applied context (Gray, 2018). Real-world research's premise is that there will be numerous factors that are likely to influence a study's outcome. It acknowledges that these are ever-present in a given context, so they need to be embraced by the research; appreciating that their impact is integral to any such study's outcome within that context. Ultimately, real-world research embraces uncertainty, contradiction and volatility; and uses these variables to help inform what we know about a specific issue, grounded within the context in which the research is being conducted.

4.3 Chosen Design

When considering the researcher's stance in relation to the design of this study, it is clear the research questions align to a more ontological perspective; although with a greater emphasis on the relativism end of the realism-relativism spectrum. Student attainment and the ability to practise safely and effectively are obviously essential to the HCPC's SoP and therefore the efficacy of the module's L&T. This is intrinsically linked to the first research question and, ontologically speaking, it is this first research objective that can be considered as seeking to identify 'what is known'. However, it is the impact of changes to the module on student's self-assessment of confidence and preparedness for practice (research objective 2), as well as their learning experience (research objective 3) that are important to the researcher.

It can therefore be argued that the research underpinnings align most strongly to a post-positivist philosophy where meaning and context are important, but there is also a need for objectivism. However, it was Pragmatism that ultimately shaped the methodological decisions. The first research objective stated in this study, in theory, lends itself to a quantitative approach. Aspects of the research aim that are concerned with self-assessment all align more to relativism; although lend themselves to being evaluated quantitatively to enable the identification of impact. The third research objective is very clearly concerned with the experiences and perspectives of the participants and would be best served by a qualitative paradigm to elicit rich data. These three research objectives reflect not only areas of the research that require further study as identified in Chapter 3, but also HE sector priorities in terms of student attainment, a quality learning experience and preparing graduates for the working world.

Within this mix of research paradigms, it was the meaning, connections and influences associated with the qualitative strand that resonated more strongly with the researcher's own personal philosophical stance. Student experiences and the perceived impact of integrating learning technologies were of significant importance to the researcher as it was the students who had instigated the module redesign and the inclusion of learning technologies in the belief that this would improve their learning experience and outcome. Ultimately, much of what shaped the research approach was the desire to undertake a study that would provide meaningful insight into the learning experiences of the students and how prepared they felt in entering CVR clinical practice; not just undertaking a study that assessed the educational outcome of the inclusion of learning technologies.

By taking a Pragmatist approach and allowing the purpose of the research to shape the methodological design choice, rather than selecting a specific philosophy which in turn would dictate the study design, a mixed methods approach was chosen. By selecting a mixed methods approach and synthesising both qualitative and quantitative methodologies, knowledge can be both constructed, and based on lived experiences

(Teddlie & Tashakkori, 2009 p89). Whilst some have argued that qualitative and quantitative paradigms are not compatible and research that combines the two is not valid (Howe, 1988), mixed methods research is now widely accepted as a robust methodology in its own right. Indeed, mixed methods research is argued to create greater meaning and insight when employed effectively (Plano Clark and Creswell, 2008).

Onwuegbuzie and Leech (2004) has argued that mixed methods (MM) research should not be rigid, but flexible; and should be designed to effectively answer the research question, combining appropriate quantitative and qualitative elements. However, MM proponents have striven to create a framework and typology in order to provide a clear structure and legitimise it as a methodology in its own right; distinguishing it from quantitative and qualitative research respectively. Whilst this need for a typology and framework somewhat contradicts the premise of creativity and flexibility associated with MM, it does provide guidance and commonality of language on which MM researchers can base their chosen methodologies. It also enables true mixed methods research to be distinguished from multi-strand and quasi-mixed methods research.

A common pitfall in the implementation of mixed methods research is the existence of the two different paradigms within one study, but in complete isolation to one another. This is known as a monomethod multi-strand study; so defined when there is no integration between the quantitative and qualitative elements at any stage of the research process. Whilst these studies are appropriate designs in the right circumstances, it is important that two strands co-existing, albeit separately, within the same study are not conflated with genuine MM.

When deciding on a MM design, integration between the quantitative and the qualitative elements is key to provide opportunities for triangulation, cross analysis and meta-inference. In order to achieve this, it is important to consider the relative order and influence of each aspect of the study and the points at which they will integrate. This will help inform the stages of implementation, data collection and analysis. If integration is not apparent across the quantitative and qualitative elements, the dichotomy of the two paradigms becomes more evident.

To be classed as true MM, integration of data sets either at analysis or interpretation stage is an essential component; as it is fundamental to the very purpose of supporting greater consideration of the research topic as a whole based on a culmination of outputs, perspectives and lived experiences. Sequencing of methods of data collection and/or analysis as well as the points for integration have led to numerous MM classifications. This is not unexpected in light of the flexible and creative element of MM. As can be seen in Table 4.1, there are multiple typologies, with similarities across each in terms of sequencing and priorities.

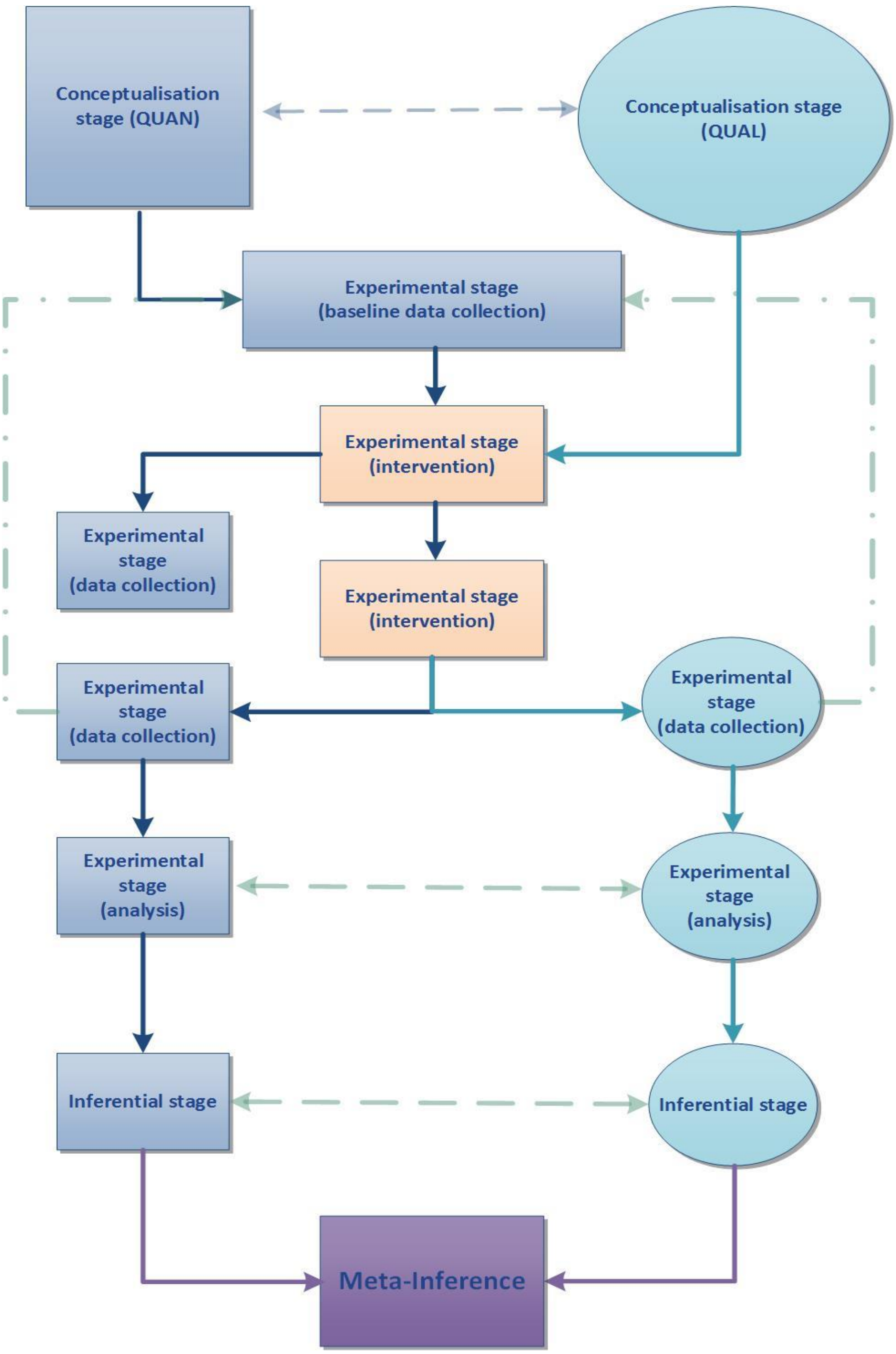
Figure 4.1 outlines this study's stages of data collection with more points for quantitative data collection than qualitative. The implementation stages were not integrated across the quantitative and qualitative paradigms, but the analysis and inference stages were. With the study taking place over two consecutive academic years, there were some opportunities for the learning from the first wave of implementation and data collection to inform the approach taken for the subsequent iteration of the module. However, due to the fairly superficial integration and influence in the implementation stage, it is felt that this study most strongly aligns to a Convergent Parallel Design (Cresswell and Plano Clark, 2011). Implementation stages are discussed in section 4.4

Table 4. 1 Outline of typologies (adapted from Plano Clark & Ivankova 2016 pg 112-115)

Authors	Typology	Associated Designs	Characteristics
Greene (2007)	Interactive-Independent Dimension Design Clusters	Component MM Designs: Convergence Extension	Timing: concurrent or variable Integration: at result interpretation Priority: equal or variable
		Integrated MM Designs: Iteration Blending Nesting or Embedding Mixing for Reasons of Substance or Value	Timing: concurrent, sequential or variable Integration: across all stages in a study process Priority: equal or unequal
Teddlie & Tashakkori (2009)	Five Families of Mixed Methods Design	Parallel Mixed Designs	Timing: occurs in parallel manner either simultaneously or with a time lapse Integration: at result interpretation
		Sequential Mixed Designs	Timing: sequential Integration: at connecting study phases
		Conversion Mixed Designs	Timing: Integration: when transforming one type of data (e.g. qualitative) into alternative type (e.g. Quantitative)
		Multilevel Mixed Designs	Timing: concurrent or sequential Integration: across multiple data levels in a study process
		Fully Integrated Mixed Designs	Timing: concurrent or sequential Integration: across all stages in a study process

Authors	Typology	Associated Designs	Characteristics
Morse & Niehaus (2009)	Mixed Method Design Typology	Qualitatively Driven Mixed Method Designs Qualitatively Driven Simultaneous Qualitatively Driven Sequential	Timing: concurrent or sequential Integration: at results' interpretation or at connecting two phases Priority: qualitative
		Quantitatively Driven Mixed Method Designs Quantitatively Driven Simultaneous Quantitatively Driven Sequential	Timing: concurrent or sequential Integration: at results' interpretation or at connecting two phases Priority: quantitative
		Complex Mixed and Multiple Method Designs Qualitatively Driven Quantitatively Driven	Timing: concurrent or sequential Integration: at connecting multiple study phases Priority: qualitative or quantitative
Cresswell & Plano Clark (2011)	Prototypes of Mixed Methods Designs	Convergent Parallel	Timing: concurrent Integration: at results' interpretation Priority: equal
		Explanatory Sequential	Timing: sequential; quantitative first Integration: at connecting two study phases Priority: quantitative
		Exploratory Sequential	Timing: sequential; qualitative first Integration: at connecting two study phases Priority: qualitative
		Embedded	Timing: concurrent or sequential Integration: included within a traditional QUANT or QUAL design Priority: unequal
		Transformative	Timing: concurrent and sequential Integration: at multiple levels as shaped by a theoretical framework Priority: variable
		Multiphase	Timing: concurrent and sequential Integration: at multiple phases within an overall programme-objective framework Priority: variable

Figure 4. 1 Sequence study and points of integration



Timing of data analysis was crucial and linked to the implementation stages. It was decided to conduct the focus groups without prior knowledge of the results from quantitative data analysis to enable participants to steer the conversation and explore areas of their module experiences most important to them. This was considered important because the primary goal of the qualitative element of the study was to provide the students with an opportunity to explore key topics in relation to the module learning experience that they felt were of priority, irrespective of learning outcome. Although the researcher had some insight into overarching levels of student satisfaction with the module prior to the focus groups, module evaluation free text responses were not formally analysed until after the focus group had concluded.

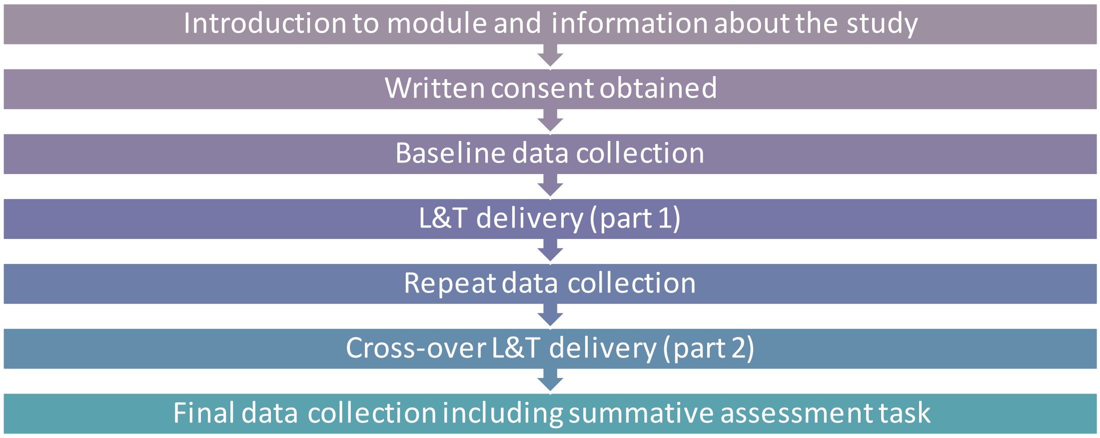
4.4 Method

Factors influencing the choice of study design range from ethical imperatives to logistical constraints. Ethical considerations are explored in section 4.8 with logistical constraints and variables discussed in section 4.7. The compulsory must-pass nature of the module meant that randomisation to either a control (traditional teaching methods) or an intervention (TEL) arm was not appropriate as this could disadvantage one group of students over another and impact on their progression and degree classification. Furthermore, in order to inform the third research objective, it was important that students experienced both the traditional and TEL approaches. In light of these constraints a quasi-experimental cross-over method was selected. Implementation of the cross-over design was subsequently influenced by the scheduled teaching delivery weeks and placement pattern as outlined in section 3.2. The potential implications for the research of the module's teaching being interspersed by placement are discussed in section 7. 5

Due to the nature of the module delivery and the aims of the study, participant blinding was neither appropriate nor achievable. As outlined in Section 3.2 the module teaching team consisted of five staff, all of whom delivered teaching as part of the module and assessed the students' clinical reasoning as part of the module's summative assessment. Assessor blinding was undertaken in relation to the other quantitative data sets within this study. These are described in sections 4.6.1 and 4.6.2. Figure 4.2 outlines the sequence of implementation and data collection.

As can be seen from figure 4.2, baseline data were collected prior to commencing the module teaching delivery in order to establish the level of pre-existing knowledge and understanding in the field of CVR; and to enable the identification of knowledge gain.

Figure 4. 2 Sequence of implementation and data collection



Module teaching then commenced, with each student group receiving a different intervention (L&T approach), outlined in Figure 4.3. Group A was assigned L&T approach 1 for the initial stages of content delivery. This consisted of traditional L&T methods and resources for a given topic. Group B was assigned L&T approach 2 for the same topics during the initial stages of content delivery. This group received traditional L&T approaches, but with the addition of access to internet enabled tablet devices to be used alongside activities in class. No specific additional TEL resources were provided for this group. Group C was assigned L&T approach 3 for the initial stages of content delivery. This group received the specifically designed resources for the given topics.

After completion of the initial stage of teaching delivery, a second round of quantitative data was collected prior to students undertaking clinical placement block two. Students then commenced their clinical placement before returning to university for the crossover intervention; receiving L&T resources in the format they had not yet received (Figure 4.3). Consideration of the impact of the teaching approaches on placement and vice versa is provided in section 7.5.

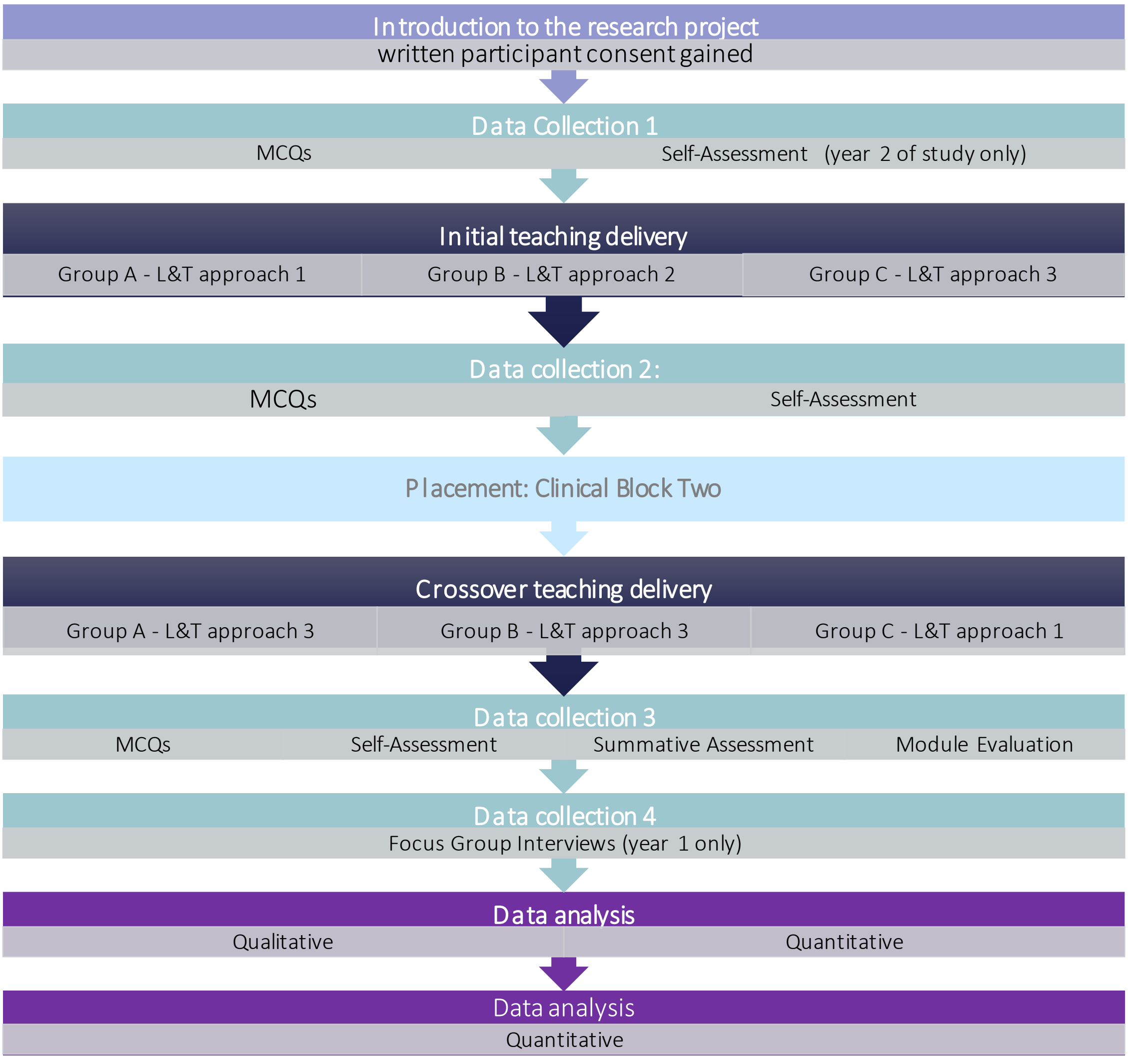
Table 4. 2 Topics / sessions in bold denote those where TEL L&T approaches and resources were specifically developed and utilised within the study.

7	**A**	**Lecture**	**Introduction to the module**
8	1	Seminar	**Cardio-Respiratory anatomy and physiology**
	2	Practical	**Ventilation and perfusion distribution; effects of positioning**
	3	Seminar	Understanding respiratory assessment
9	4	Practical	Cardiovascular assessment - incorporating practical assessment skills stations for auscultation, percussion note, palpation etc
	5	Seminar	Impact of environment: consideration of the impact different environments have on patients
	6	Seminar	Understanding and interpreting arterial blood gases (ABG's) - including gas transport, oxygen dissociation, acid-base balance
10	7	Seminar	**Pathology recognition (i)** impact and clinical presentation of secretion retention
	8	Seminar	**Pathology recognition (ii)** - impact of loss of functional lung volume. - linking sputum retention and loss of volume - developing understanding of the pathophysiology and clinical presentation of COPD
	9	Seminar	**Pathology recognition (iii)** - interpretation of CXR's
13	10	Seminar	Problem identification and goal setting
	11	Practical	**Airway clearance and respiratory techniques**
14	12	Practical	Oxygen therapy, titration and humidification
	13	Practical	**Principles of ventilation**
15	14	Practical	Rehabilitation of the respiratory patient
	15	Seminar	Evaluation of practice in respiratory care
21	B	Seminar	Written assignment support sessions
24	16	Practical	**Introduction to SIMMAN**
25	17	Practical	**SIMMAN practical**
26	18	Practical	Formative SIMMAN assessment – preparation for the module assessment task

On completion of the module assessment task, students were asked to complete the module evaluation form. This was a standard university-wide module evaluation form with a small number of additional questions pertaining to specific learning technologies and approaches (Appendix 13). This data set is discussed in more detail in section 4.6.4

After completion of Year 1 of the study, focus group interviews were then arranged. Based on a topic guide (Appendix 10) these were used to explore the learning experiences of students throughout the module and their preparedness for clinical practice. Three focus groups were scheduled after the first complete iteration of the module. Each focus group consisted of a maximum of 6 students.

Figure 4. 3 Schedule of delivery and data collection for crossover and self-assessment aspects of project



4.5 Sample Size and Sampling Strategy:

4.5.1 Recruitment for Formal Testing

Employing an appropriate sampling strategy is an essential component of any robust quantitative research study, if findings are to be generalised to a larger population (Waterfield, 2003). There are several sampling techniques that can be employed, but it is important to consider the context of the study itself including the research objectives and the data being collected (Creswell and Plano Clark, 2011). Ensuring that the sample is representative of the larger population on which inferences are to be made enables the data produced to be generalised more widely (Waterfield, 2003).

This study is situated within a compulsory module of professional educational programme. It was therefore inappropriate to employ a probability sampling technique where a random proportion of the student cohort would receive the new L&T approach. Instead, a convenience sample of all the Level 5 students undertaking the specified module was used to request participation in the study. Students were invited to participate in the project at the start of the academic year; an outline presentation was given; information sheets were provided (Appendix 6) and written consent from those students wishing to participate in the study was gained (Appendix 7). All students in each iteration of the study consented to participate and were enrolled in the study. Students were also informed that their data from the module's summative task would be used anonymously as part of the research.

As students were already allocated into sub-groups within their cohort, a probability cluster sampling technique was employed for the MCQ and self-assessment data sets, thereby ensuring that group allocation was maintained, and preserving group and peer dynamics. It was important to ensure that established peer learning dynamics were not disrupted as part of this study as this is could influence student learning. As the module summative results were being compared to the MSK and neuro modules running concurrently, it was important not to introduce an additional variable that could influence student outcome. Random allocation to different L&T approaches was therefore not feasible; hence each sub-group was allocated to a particular intervention (Figure 4.3).

Despite the inability to determine the sample size of the study, it was important to consider what would be deemed the minimally significant difference for a student in terms of their learning, based on the re-designed module. Degree classifications within the HEI in which this study was conducted equated to: 40-49% being a third class; 50-59% being a lower second class; 60-69% being an upper second class and 70-100% being 1st class.

For the MCQ and module summative assessment task it was decided that 4 percentage points would be educationally significant as this would be the difference between sitting in the higher proportion of a lower classification and moving up to the next classification. Whilst this study was only at modular level, it is important to consider degree classification both in terms of the individual student and their employment potential, and also the metrics by which HEIs and learning gain are measured. Therefore, using marking classifications albeit at module, not degree, classification level was deemed an appropriate relative measure.

A power calculation was undertaken (Table 4.3) to identify the minimum cohort size required to detect a statistically significant difference between the research cohort and previous cohorts acting as a control (module summative marks). In addition, a sample size calculation was performed to identify the group size required to detect statistically significant changes between sub-groups as part of the crossover (MCQ and self-assessment). The resulting calculations indicated that the study should run over two successive years in order to ensure a sufficient sample size.

Table 4. 3 Sample size calculations

	To compare current cohort's summative module mark against previous cohort	**To compare impact of different resources on learning across groups within current cohort (crossover)**
Minimally important difference	5 marks (per 100)	4 marks (per 100)
Level of significance (p-value)	0.05	0.05
Power	0.8	0.8
Effect size/estimated SD	0.4	0.5
Sample size needed	66	34

4.5.2 Recruitment to Focus Groups

Estimating the relevant sample size for qualitative studies is arguably as important as in quantitative studies (Malterud et al, 2016b). However, in the context of qualitative research, the guidance as to the estimation of a suitable qualitative sample size can be somewhat vague (Carlsen and Glenton, 2011). It has been said that for each study utilising focus groups, at least three groups should be arranged, with further organised until data saturation is achieved (Teddlie and Tashakkori 2009, pg 183). Further guiding principles for determining sample size in qualitative research include sufficient group numbers and heterogeneity (Krueger & Casey 2009).

The composition of focus groups is recommended to be 6-10 people (Krueger and Casey, 2009; Litosseliti, 2003; Pope and Mays, 2005); although it is acknowledged that numbers can range from as few as four to as many as 12 (Kreuger, 2014). It is stated that group size decisions should be governed be the following: small enough that everyone has a voice, but large enough to provide diversity of perceptions (Kreuger and Casey, 2009). Additional consideration should be afforded to the balance between heterogeneity, to ensure diversity, and homogeneity in terms of the nature of the group's experience and comfort with other participants (Morgan, 1997).

Data saturation is a key consideration when establishing sufficient sample size in qualitative research as failure to reach saturation limits the quality of any findings (Fusch & Ness, 2015). Many definitions of data saturation exist but as a term it can largely be distilled as the point at which no further data are being found (Saunders et al., 2018) and when further coding is no longer feasible (Fusch & Ness, 2015). Achieving data saturation within qualitative research enables the discontinuation of data collection (Tashakkori & Teddlie, 2009). Sufficient focus groups were therefore required in order to ensure no additional new data was being generated.

A convenience sample of volunteers from the student cohort was recruited at the end of the academic year. Drawing from the student cohort meant that there was a level of homogeneity in terms of experience and a potentially narrow domain. Three focus group interviews were scheduled based on student availability with five, six and three participants respectively. Whilst this could be seen as a potential limitation, it can be argued that group size as low as three or four can be sufficient, if facilitated appropriately, enabling individual voices and views to be explored in more depth (Barbour, 2001). Issues taken into consideration when determining viable focus group size therefore included sufficient numbers of participants to generate and maintain stimulating dialogue whilst ensuring all members had an opportunity to contribute.

The groups were not self-formed or restricted to teaching sub-groups. Whilst the lack of established peer relationships could potentially impact on group dynamics, the focus groups were structured in such a way that early activities aimed to promote the development of relationships and a supportive and inclusive environment. Fostering positive group dynamics is essential within focus groups as this can enable participants to become co-researchers, exploring concepts and opinions that the researcher had not anticipated (Pope and Mays, 2005).

As recollection of experiences were key to the study, it would not have been appropriate to delay the focus groups until completion by the second cohort. Participation by the second cohort in the focus groups was not sufficient to run a second wave of qualitative data collection, so delaying recruitment until the pool was larger, would have been unlikely to yield increased recruitment.

4.6 Data Collection

As discussed in Chapters 1 and 2, underpinning knowledge, critical thinking and the ability to make reasoned clinical judgements are established pre-requisites for clinical reasoning and professional practice (Benner, Hughes and Sutphen, 2008). When considering the different components required for clinical practice and professional registration, it is prudent to consider both Anderson and Bloom's's (2001) adapted cognitive taxonomy of learning and Kolb's (1984) experiential learning cycle. By understanding the various components of learning, it is possible to identify different means of assessing these components of learning; whilst assessing student achievement against the defined educational outcomes of the module.

For this study, it was important that different data sets were utilised to enable the impact of different L&T approaches to be ascertained and differentiated. Understanding whether different L&T approaches help support progression through the levels and stages of learning, or whether certain approaches impact predominantly on specific stages of learning is an important aspect of the study.

Table 4. 4 Overview of stages of learning and potential means by which to assess them

Taxonomy of learning	Learning cycle	Means of assessment within the Module
Remembering and understanding	Concrete knowledge and experience	Multiple choice questions
Analysing	Reflective observation	Self-Assessment and guided reflection
Applying	Active experimentation	Demonstration / simulated clinical scenario

The following outcome measures were used to inform the study objectives and create a number of different data sets.

4.6.1 Multiple Choice Questions

Multiple Choice Questions (MCQs) are a type of test that provides a range of possible answers to a question or incomplete statement from which the student selects what they believe to be the correct one. Each MCQ consists of two parts: the stem, which states either the question or contains the incomplete statement; and the options which contain the correct answer and a range of incorrect ones (Brame, 2013). They are widely used to assess knowledge in undergraduate medical education programmes (Brame, 2013) although their value in assessing higher level thinking has been questioned. Palmer and Devitt (2007) identify that Mini Essay Questions (MEQs) better enable students to demonstrate the depth and breadth of their knowledge, understanding and application. However, Moore and Parker (2001) argue that critical thinking for nursing students can be effectively demonstrated through carefully constructed MCQs. Therefore, whilst not without their limitations, MCQs are an established method of assessing knowledge and understanding within healthcare education (Epstein, 2007). When utilising MCQs to ascertain level of understanding and critical thinking, it is important to ensure that their design enables not only the assessment of knowledge and recall of facts, but also interpretation, synthesis and application (Glaser, 1984). Consideration includes sentence structure, avoiding double negatives and the precise use of wording (Brame, 2013). Reliability, consistency and validity are also important factors when designing robust methods for testing knowledge and understanding.

The MCQs used in this study (Appendix 11) were predominantly written by the Module Leader (Researcher) in the two years prior to the study, with contributions from the module teaching team. The module team was asked to review the questions in terms of expected level of knowledge relative to the module learning outcomes and clarity of language used. The questions were not formally evaluated in relation to their accessibility, although common pitfalls such as the use of double negatives that can unduly penalise some students with specific learning contracts (Chiavaroli, 2017) were avoided. Questions were designed and cross-referenced with relevant external reference points such as respiratory physiology and pathology textbooks and workbooks. By consulting with the module team in addition to cross-referencing with external sources, it could be argued that face validity was assessed. The MCQs had been used in previous iterations of the module as formative assessments, the results of which had shown similar results between sub-groups of those cohorts, although again this was not formally assessed. Consistency in an MCQ test is said to be demonstrated when similar results are observed when administered to a range of similar subjects (Brame, 2013).

4.6.2 Self-Assessment Questionnaire

Prior to the study, students had reported a disconnect between what was being taught in the university in the field of CVR and its application to the clinical context, affecting their perceived preparation for practice. It was therefore important to ascertain whether the different L&T approaches within this study impacted on the students' assessment of their own transference of learning and competence to a clinical setting.

Self-assessment of competence and confidence is an important skill as it is necessary for ongoing professional registration (HCPC 2013). Self-confidence has been linked to positive actions and decision-making within clinical practice (Moody and White, 2003). Competence and confidence are therefore important issues in healthcare education, with the two elements being seen as separate yet inter-related (Stewart et al. 2007). Moody and White (2003) identified a direct link between self-efficacy and self-confidence which in turn was seen to be a major component within clinical decision-making.

In order to inform the second of this study's aims, a self-assessment of competence measure previously designed and validated by the researcher to aid UG Physiotherapy students identify both areas of strength and ongoing learning needs in preparation for clinical practice was utilised. The self-assessment questionnaire (Appendix 12) was designed and validated in 2010. It was adapted from the nationally recognised Acute Respiratory / On Call Physiotherapy Self-evaluation of Competence Questionnaire and mapped to the year 2 and year 3 CVR programme learning outcomes, as well as the NHS Knowledge and Skills Framework (KSF) used at that time to define expectations of a graduate Physiotherapists working within the NHS.

The questionnaire was split into five areas deemed key to clinical practice: assessment, problem identification; interventions/treatment techniques; analysis and communication and clinical environment. Students were asked to rate their perceived level of ability in these areas. The rating process utilised a five-point Likert scale from strongly disagree to strongly agree with statements. There were sixty statements in total that required rating, plus an area to identify what cardiovascular-respiratory clinical experience the student had gained on placement. The rating assigned by the student for each statement was assigned a numerical value: 1 for strongly disagree; 5 for strongly agree.

The self-assessment questionnaire was validated for test re-test reliability and internal consistency. Focus groups were also undertaken to ascertain student perceptions of its value and application. Cohen's Kappa for test re-test reliability was 0.749 (0.696 – 0.802). Cronbach's alpha results for each section are provided in Table 4.5. Feedback from students who took part in the focus group discussions indicated that it supported the development of self-confidence as well as being a valuable tool in identifying ongoing learning needs. Students within the focus group felt it should be a mandatory requirement prior to placement.

Table 4. 5 Internal consistency results for the self-assessment questionnaire

Questionnaire section	α
Patient Assessment	0.842
Problem Identification	0.821
Interventions/Treatment Techniques	0.893
Analysis/Communication	0.786
Clinical Environment	0.932

The scale was designed to be evenly spaced from strongly disagree; disagree; neither disagree nor agree; agree and strongly disagree. Therefore, it was deemed appropriate that the numerical score attributed to the rating process was seen as interval data, rather than categorical. It is acknowledged that opinion is divided as to whether Likert scale outputs can be interpreted as interval data (Allen and Seaman, 2007). However, as the rating has been designed to be evenly spaced across the differing levels of agreement, the decision to term the data interval is supported by the literature and can be analysed as such (Harwell and Gatti, 2001).

Due to the scoring system, the minimum score for an individual who disagreed with every statement about their ability to assess, identify problems and plan appropriate treatments would be 60; with a maximum score of 300 for an individual who strongly agreed with all statements. In Year 1 of the study the self-assessment questionnaire was completed by students after completion of the first L&T approach, immediately prior to placement, and again after cross over delivery at the end of the module. The rationale for not including the self-assessment at the baseline MCQ stage was that a baseline of self-assessment had not been instigated previously as it was felt more appropriate to be introduced prior to placement. Furthermore, it was assumed that students commencing the module would have little cardiorespiratory experience and knowledge due to the scarcity of CVR teaching in Year 1 and only one placement opportunity prior to the module; and hence students would mostly likely strongly disagree with many of the statements. However, in year two of the study the questionnaire was introduced at the baseline MCQ stage. This was not for the purpose of the study; it was as a result of student feedback from Year 1. Anecdotal feedback from students in Year 1 of the study indicated that they felt introducing the questionnaire at the outset of the module would not be demotivating but would help them understand what was expected of them both in terms of the module's aims and in preparation for practice. Whilst at the time it was felt that introducing the questionnaire at baseline would not impact on the study, the implications of this change are discussed in section 7.5.

4.6.3 Assessed Simulated Clinical Scenario and Module Mark:

Marks from the module assessment tasks, outlined in section 3.2.5, were used to inform questions about whether the changes to the module's L&T as a whole had impacted on student clinical reasoning.

The assessment tasks were marked by the module team who had undergone a consistency exercise prior to the assessment task. The clinical scenario consistency exercise comprised of markers independently viewing and assessing a student undertaking a simulated assessment task using the module's marking criteria. This was then followed by a module team discussion of marks awarded against each learning outcome and examples of feedback they would provide. The video used for this consistency exercise was created specifically for this purpose. A Year 3 student volunteered to perform the assessment task and for the task to be videoed. None of the module team who assessed the students in these tasks had access to the MCQ and self-assessment data and hence were blind to the other quantitative data generated by this study.

Student marks from the simulated assessment task were compared to previous cohorts to ascertain if combined L&T approaches had an overall impact on clinical reasoning. The previous two cohorts acted as a control as they received traditional teaching alone and the same summative assessment task. In addition, the overall module mark (the combined mark from the practical assessment and the written assignment, weighted equally) was used as a comparison against the other two specialist modules to ascertain if student assertions that the CVR module was the hardest were reflected in overall lower marks when compared to the other two specialist modules. It was hoped that this would help to highlight whether this learning gap was addressed following the module redesign.

4.6.4 Module Evaluation Questionnaire

At the time of the study the standardised university module evaluation form was in operation. It had been designed to be analogous to those questions asked within the NSS and Post-graduate Taught Experience Survey (PTES). Its use was intended to help course teams identify modules within their course that were received well by students and those that required improvement. Staff were required to use the responses garnered by these questionnaires as part of their annual module review and as a means to celebrate success and identify possible changes for the following year. The standardised module evaluation form had been utilised in previous years but for the purpose of this study authorisation to include specific questions as to the learning technologies utilised was sought (Appendix 13).

The module evaluation form required students to rate their level of agreement with statements about their experience of the module via the use of a five-point Likert scale. In addition, there were a number of free-text questions that invited students to provide constructive feedback about the module providing valuable insight as to their experience of the module as a whole. The balance of statements and free-text opportunities provided a range of quantifiable data enabling inferences to be made. In addition, the free-text questions provided a richness of data that could be used to provide context and explanation of the rated statements. Whilst the module evaluation form had not been specifically validated within the institution, its similarity to the NSS questions enabled the researcher to infer similar conclusions as to its reliability and validity to other metrics that are universally used across the sector.

The module evaluation form was provided in electronic format to each student on completion of the module assessment task for each of the study cohorts. The form was created in a Google Form format which the students completed via an iPad provided on exiting the assessment. Providing the module evaluation forms to students in-class on completion of the module teaching, or after completion of the practical assessment task was standard practice across the Faculty at the time. There was 99% completion rate of the module evaluation form. This is likely due to the nature of these forms being provided to students directly. Module evaluation forms are now available online for students via an email that asks them to complete. This enables students to complete the form if and when convenient for them. The data generated was outputted as a spreadsheet. Whilst perceived performance within the assessment task could have swayed students' perceptions of the module's L&T overall, it was important to the researcher to ensure as full a picture as possible by having the largest sample size possible. This strategy was to provide the researcher with valuable insight into the perceptions and experiences of as many of the students on the module as possible.

4.6.5 Focus Group Interviews

Focus group interviews were deemed the most appropriate to inform the third research aim by enabling students to share experiences of different learning and teaching resources. A topic guide (Appendix 10) was developed to support the process. Whilst the topic guide was written to provide structure and facilitate the exploration of key issues to ensure the research objectives were met, its purpose was to guide the researcher and ensure all areas were explored.

The focus groups began with discussion and agreement of the terms of each group in terms of confidentiality and respect for each other's views, followed by an icebreaker activity. Ice breaker activities for focus groups have been described as a means to engage participants in the objectives of the group and enable the researcher to become acquainted with the group dynamics and interactions (Kilanowski, 2012). In light of the timing of the focus group being some distance from the module / study delivery, the icebreaker activity was focused on what the students could remember from the module itself. Participants were asked to undertake a whiteboard activity, collectively identifying what they could remember from the module, indicating via the use of a smiley face or a sad face whether it was recalled in a positive light or negatively. This was then compared to the module content document to identify areas of L&T that had been inadvertently forgotten. Further discussion of the role of the icebreaker activity and the observations of the researcher will be explored later in this chapter.

Despite the topic guide, the researcher adapted the flow of the focus groups based on key issues arising from the ice breaker activity. This was to maintain dynamics and flow; and to ensure that the most meaningful and relevant issues for the students were explored. Some key areas were covered to ensure the primary objectives were met, but the order in which these were addressed, and how they were explored, was directed by the participants. Participants were given the freedom to talk about the issue most pertinent to them. By allowing the conversation to flow naturally, and at times veer away from the key questions within the topic guide, participants were afforded the opportunity to share the experiences that resonated most strongly for them.

None of the quantitative data was analysed prior to conducting the focus groups. Whilst there is some discussion within sequential explanatory mixed methods about using the secondary approach to provide context and/or validate the primary research paradigm (Creswell & Plano Clark, 2011) it was important to the researcher to interview participants without prior knowledge of the outcome of the quantitative data collection. The reason for this was to limit bias and to enable participants to dictate the flow and emphasis of discussions. Each of the three focus groups were video and audio recorded with a combined approach triangulating transcription and observation to analyse the discussions and generate emergent themes. A detailed description of the process of integrating visual methods with transcription; and the additional insight this afforded in the data analysis process is provided in section 4.9 of this chapter.

4.7 Identifying Mediating Variables

As previously discussed, undertaking research in an applied educational context provides a number of challenges, specifically in relation to the range of possible variables that may influence the learner experience and outcome. Regardless of the premise of real-world research, any study wishing to draw meaningful and robust conclusions based on the findings they produce must consider how best to take account of these.

Potential factors affecting the outcome of the study were acknowledged as either occurring prior to the module or during its delivery. Factors that occurred prior to the module delivery are likely to have influenced a student's baseline knowledge and understanding, approach to learning and study or their ability to transfer concepts to a clinical context. Previous educational experience, range of subjects studied, as well as time since formal study were considered by the researcher as examples of a priori factors. The course entry requirements are such that there are a number of ways an applicant can achieve the necessary points in order to be offered a place on the course e.g. A-levels, BTEC, Access Course, Foundation Degree; as well as equivalent international qualifications.

This range pf educational experience brings with it a potential richness of data due to the range of experiences, knowledge and cultures that students may bring. However, some students may be at an advantage over others educationally due to the nature of their recent studies or the proximity of their previous qualifications to commencing the course. Whilst these are all valid factors that may affect learning baseline and, in theory, learning gain potential, these variables cannot be accounted for within this study.

As all entry requirements are deemed equivalent academic level it could be argued that whilst the journey to the respective entry qualification will have been different, the level of achievement is comparable. As this is a Year 2 module, issues of student transition and familiarity with the L&T approaches employed by the course team should already have been addressed. Therefore, whilst these factors could be seen as potential variables, their presence is expected and has not been seen to be of sufficient influence to warrant their consideration relative to previous student attainment. The range of previous educational experiences was deemed to be representative of the usual cohort of students, so it was not considered as significant or likely to impact on the comparative nature of the study. However, these factors were identified within the second wave of quantitative analysis to identify if their presence could be a factor in influencing outcome and perceptions of ability.

Another consideration is prior clinical experience in the field of cardiorespiratory healthcare. Some students will have worked in healthcare prior to commencing the course, which could provide a greater basis on which to apply theoretical content to the cardiorespiratory context; although this experience would likely to have been through an observation visit / placement or as part of a different role within the cardiorespiratory healthcare context. As discussed earlier, students reported that the clinical content of the module’s teaching was often difficult to visualise, apply or transfer into the clinical context, especially with little or no cardiorespiratory experience on which to draw. Enabling students with the baseline CVR skills to visualise and then adapt to the range of possible environments is especially challenging in light of the changes to healthcare service provision.

The shift towards primary care and the range of environments in which physiotherapists are likely to encounter patients with cardiorespiratory compromise is increasing; and so too is the need for physiotherapy programmes to equip their graduates with the skills to transfer their knowledge to the relevant clinical context. However, irrespective of prior cardiorespiratory-specific experience, all students should have undertaken a four-week placement at the end of the first academic year. This will have provided a basic grounding and exposure to history taking, assessment, problem identification and clinical reasoning. As previously discussed, an essential component of clinical reasoning is experience. All practice-based experience is therefore valuable in facilitating the development of clinical reasoning. Therefore, all students will have benefited from this mid-module clinical placement, regardless of whether they have experienced cardiorespiratory patients.

In addition, the module redesign aimed to provide aspects of the clinical context-specific content that had previously been identified as missing, bridging the gap and offering opportunities for students to gain simulated cardiorespiratory experiences in the absence of cardiorespiratory patients. Whilst it is acknowledged that providing all students with cardiorespiratory clinical experience prior to the module would ensure greater parity, it is neither feasible nor a guarantee that students would better understand the subject matter.

Variables that could not be controlled during the delivery of the module (and hence the duration of the study) include the amount of additional study each student undertook and also the type of placement the student experienced between the two teaching delivery periods (Clinical Placement block 2; figure 3.1). Some students on this second placement block may experience cardiorespiratory patients within primary or secondary care, or within the third sector; however, these students will not be in the majority. So, again, whilst everyone will gain additional clinical experience, a significant proportion will not have gained experience specific to the module. Students who undertook a cardio-respiratory placement over the course of the module were anecdotally reported by their peers as having an advantage; however, the experience of the module team assessing these students would suggest this assumption is not entirely accurate. It was decided not to collect such data, so it is impossible to support or contest this assertion.

The aforementioned extraneous pre- and peri-module variables notwithstanding, consideration was given to the best way to identify learning gain, and specifically any impact that could be attributed to the newly incorporated learning technologies. Ordinarily a simple randomised controlled trial (RCT) with one student group receiving only traditional teaching and the other receiving the additional learning technologies would enable differentiation in terms of respective impact on learning and understanding. However, the module was a mandatory one within an undergraduate professional healthcare education programme; and hence it was deemed unethical to undertake a randomised controlled trial due to the potential to disadvantage one particular group of students.

Due to the quantitative and comparative element of the research aims, it was necessary to consider a methodological approach that would enable differentiation between convention L&T approaches and those that integrated learning technologies. A quasi-experimental, crossover design was therefore identified as the most appropriate mechanism for achieving this, as all students would receive both forms of teaching. No student, therefore, would be disadvantaged, but with appropriate data collection points interspersed between teaching blocks, there would be the opportunities for comparison. The module structure was such that there were two key delivery points interspersed with a practice-based placement and the inter-professional education teaching week (Figure 3.1). These defined points of teaching delivery lent themselves to a crossover design.

The student cohort undertaking the module consisted of three established sub-groups due to the cohort size and the need to provide adequate staff-to-student ratios for practical teaching sessions. These three pre-determined subgroups were timetabled independently to the teaching team. To accommodate this logistical constraint, for every given teaching session, three different versions were designed to meet the same learning outcomes. Whilst this deviates from a true crossover design due to the three arms of the study, it did enable the study to identify whether the mere inclusion of hardware that facilitates the access of digital resources was sufficient in improving learning when compared to specifically designed learning technologies and resources. Although this was not a formal objective of the study it did provide an opportunity for greater insight into the learning practices of students and their perceptions of whether hardware and access to open resources were seen as an enhancement to their classroom learning experience. The three different L&T approaches undertaken are outlined in Table 4.6

Table 4. 6 Overview of different L&T approaches designed for each sub-group of

L&T approach	L&T approach 1: Traditional L&T methods	L&T approach 2: Traditional L&T methods plus the provision of tablets and access to the internet	L&T approach 3: Specifically designed TEL resources based on student feedback
Rationale of L&T approach in light of study aims	To identify whether the redesign of the module in term of structure, approach and spiral curriculum alone impacts on student learning and experience	To identify whether the provision of additional hardware (but the absence of specific L&T resources), with the traditional approach impacts on student learning and experience	To identify whether the inclusion of specifically designed and incorporated learning technologies alongside the spiral curriculum impacts on student learning and experience

By considering the aforementioned mixed methods typologies and by taking a pragmatist approach to the design and implementation of this study, the researcher was able to identify the timing of the different strands and the points of integration (Fig 4.2). These decisions were influenced by the logistical constraints of the module delivery, in keeping with real-world research. The delivery pattern, however, whilst providing some challenges, naturally lent itself to a crossover design. Due to the crossover nature of the study, however, it was not possible to undertake a fully integrated approach to all aspects of the mixed methods design, resulting in a sequential data collection process (Figure 4.2).

The qualitative arm of the study aimed to explore the student experiences of both traditional teaching and the learning technologies. It was therefore important to ensure that all students had experienced the full range of L&T approaches and resources in order to inform the study objectives and hence had completed the module. Hence this aspect of data collection was scheduled to take place on completion of the module. In order to achieve the study's third research aim, student perspectives were sought via two qualitative means: open ended questions within the module evaluation form; and the use of focus group discussions on completion of the module. Focus groups were identified as the most appropriate form of data collection over, for example, individual interviews, as focus groups provide greater potential to expand on discussions and explore both shared and contrasting experiences (Kreuger and Casey, 2009); potentially providing a richer pool of data (Leung & Savithiri 2009). The purpose of this element of the study was to gain greater insight into the student experience in light of the inclusion of learning technologies. Whilst it could be argued that individual interviews would enable the researcher to explore each participant's perceptions in detail, it was important to give students the opportunity to have an active dialogue with their peers in order to shape, challenge and unpick their perceptions themselves. Whilst there are limitations with this approach in terms of ensuring an equal voice for all participants and opportunities for all views to be shared (Kreuger and Casey, 2009), it was deemed more preferable than individual interviews due to the discursive nature of the group approach. Individual interviews were deemed to be less appropriate than focus groups in this context as the researcher was also the module leader.

4.8 Ethics

Adherence to ethical principles, procedures and regulations has been a requirement of all bona fide research studies Since the Nuremberg Code was introduced in 1947 (Parsell, Ambler and Jacenyik-Trawoger, 2014). Subsequent to this there were attempts to provide an ethical framework on which medical research should abide, namely the work of Beauchamp and Childress (2001). The ethical philosophies that underpin these requirements have been predominantly shaped by consequentialism and deontological ethics (Hallgarth, 1998). Deontological ethics emphasises duty, rules and processes whereby the morality of the action itself is judged, not the impact or outcome (Chadwick, 2012). Conversely, consequentialism argues that actions should be judged on whether they are right or wrong based on the outcome (Spielthenner, 2005; Brooks et al, 2014). It is these two philosophies, respectively, that shape modern research ethics.

The overarching principles on which the legal frameworks and standards of good practice are derived are taken from biomedical ethical practice and consist of beneficence, justice, autonomy and accuracy (Beauchamp and Childress 2001; 2013). These principles are described as ensuring that participants benefit; demonstrating fairness and equity; avoiding harm; and enabling individuals to make reasoned, informed choices. They are often adapted for different contexts, professional practice and regulatory bodies.

For this study, these categories were broadly defined as: beneficence and non-malfeasance; integrity; impartiality; informed consent; confidentiality and anonymity. Beneficence / non-malfeasance is described as ensuring the welfare of all participants, preventing or removing risk and harm, and practising in a way that is of benefit to the participant (Brooks, Te Riele and Maguire, 2014). The potential risk to the participant within this study was identified as being in relation to the outcome of the students' learning within the module. The module in which this study was conducted was a compulsory module which contributed towards a professional qualification; and hence the summative module mark awarded contributed towards the overall degree classification of the student. Therefore, experimentation ran the risk of any negative outcome potentially impacting on professional qualification.

It was considered unethical to randomise students to either traditional teaching or the previously un-tested intervention of learning technologies, as there was a potential risk that the unknown nature of the experimental arm of the study could cause some students to be inadvertently disadvantaged. In order to mitigate any potential disadvantage and to ensure beneficence, a cross-over design was chosen to guarantee that each student received traditional learning and teaching resources which were known to be effective. Although there are acknowledged methodological limitations with this design in terms of rigour, it was deemed to be the most ethical in the context of this study. This highlights some of the challenges with undertaking educational research; and some of the criticisms levied: a more robust methodological approach would have been a randomised control trial (RCT). However, methodological rigour needed to be balanced against non-maleficence. In order to mitigate against the limitations of the chosen design, data collection was scheduled to enable appropriate inferences to be made relative to the respective L&T interventions.

The MCQs and self-assessment tool had previously been utilised as formative assessment tasks within the module. By using these more formally as data collection tools for the study, useful data could be gleaned to inform the research aims, whilst placing no additional assessment burden on the students. These outcome measures were tools previously used to support student learning and hence were seen as of educational benefit. Ensuring that students were able to access their own results in support of their learning was therefore of ethical importance as withdrawing this function in order to maintain participant blinding would not align to ethical principles of beneficence.

Integrity refers to the requirement for every study to be scientifically sound, contribute to knowledge and have access to quality supervision (Universities UK, 2019). As discussed in Chapter 3, the impact of blended learning on student attainment and transference of knowledge to professional healthcare practice has not yet been fully explored. Due to the gap in the literature, there is potential for this study to contribute knowledge in this field and add to the body of evidence. The research proposal was peer-reviewed at three key stages: at inception and enrolment onto the doctoral programme (Appendix 5); prior to initial data collection whereby ethical approval for the study was officially granted by the University ethics panel (Appendix 8); and at progression stage where rapporteurs reviewed an extended proposal, early findings and conducted a viva with the researcher (Appendix 9). At each stage, official authorisation and approval to proceed was granted. The supervisory team and internal assessors consisted of experienced researchers with a wealth of methodological and supervisory experience; as well as in-depth knowledge across healthcare, learning teaching and assessment in Higher Education, and student experience agendas.

The purpose of research ethics is for the protection and safeguarding of participants (Beauchamp and Childress, 2001). It is, however, prudent to acknowledge that what is collectively deemed acceptable ethical behaviour is based on, or at least shaped by, societal norms of the time. These, therefore, are likely to be subject to change; and have certainly evolved over the second half of the last century. In addition, whilst research ethics are shaped by rules and consequences that govern actions, these themselves can be open to interpretation. Indeed, one's own derived morals and values are likely to affect judgements on what is just, fair and ethical (Swanton, 2001).

Virtue ethics could be seen as an amalgamation of deontological ethics and consequentialism as it not only asserts the importance of the consequence of an action, but it also places credence in the value of the process itself. However, within this philosophical stance is a greater focus on the intrinsic positive drivers that ultimately influence a chosen course of action. Virtue ethics emphasises the feelings, desires, motives, emotions, morals and values that comprise an individual's behaviours (Swanton, 2001). It is less focused on the ethics of acts performed based on rules, or the subsequent consequences of acts, and is more concerned with how we practise ethics in our daily lives in the pursuit of happiness and fulfilment of ourselves and others (Hursthouse, 1999). It can be argued that behaviours that are intrinsically shaped through the resolution of dilemmas and conflicts, and the underpinning premise of 'to care', demonstrate virtue ethics. Virtue ethics therefore place greater importance on character and how this drives the actions rather than duty/rules dictating what should be done in a mechanistic way (Hursthouse, 1999; Swanton, 2001). Whilst the relevance of virtue ethics in research is debated (Hooker, 2002), it is hard to overlook the potential influence one's own character, moral code and desire for others to flourish may have on decision-making and actions; especially in the context of healthcare and education. However, the relevance of virtue ethics for this study in particular, pertains to: participation in and withdrawal from the study; and behaviours in the focus group and the actions taken by the researcher in relation to this.

Independence and impartiality are requirements for honesty and the declaration of any potential conflicts of interest. At the time of study commencement, the researcher was a member of the Physiotherapy teaching team. Subsequently she was the Lead for Innovations in Teaching for the Faculty, promoting the sharing of good L&T practice and providing steer to the Faculty Leadership in relation to developments in learning technologies and the implications for curriculum design and delivery. The role was also line manager to the TEL Team who provided advice, support and training for staff on a range of digital platforms and skills to support L&T practice, as well as the creation of bespoke online learning packages and objects. It could therefore be argued that the researcher had a vested interest in investigating and reporting the impact of learning technologies, sharing what was learnt with the wider L&T community. The researcher, however, was impartial to the result, merely invested in sharing any insights gained.

4.8.1 Consent, Confidentiality and Anonymity

Informed consent is an essential component of research ethics (Beauchamp and Childress, 2001) and is based on the moral and legal premise of patient autonomy; that everyone has the right to make decisions. In this context, a decision about their L&T experience. Students were informed of the research project at the outset of the module, given written participant information (Appendix 6) asked to consider the study and if they wished to participate to provide written consent (Appendix 7). They were also explicitly given the opportunity to opt out from the outset of the study. Students were made aware that the study ran the duration of the module and were informed that they were entitled to opt out of the formative MCQ and self-assessment testing at any point during the module. Opting out consisted of not consenting to the study, by not returning a written consent form or by informing the researcher that they did not wish to participate in or would like to withdraw from the study. As the addition of new technologies and L&T approaches were the experimental element, students not wishing to participate and/or withdraw from the study would still receive all traditional L&T, but they would not be required to undertake the MCQ and self-assessment data collection exercises.

Consent was given by all students participating in the module each academic year of the study. Why uptake and consent were so high will be discussed in section 4.8.2.2.

Confidentiality and anonymity requirements are such that all research must conform to data protection legislation, the latter having changed during this study. Students were informed that no quantitative data analysis would take place until after the module was completed. Assessor blinding of quantitative data through the use of student ID numbers also ensured that student data remained anonymous and no tutor was aware of individual student outcomes from the MCQs or self-assessment tool. Assessor blinding was employed for all the quantitative data collection. MCQ, self-assessment and module marks data were downloaded in a format that enabled paired data to be analysed, but with no participant identifiable information. No quantitative data was accessed or analysed until the students had formally completed all module summative assessment tasks and the focus groups had been conducted.

All data and confidential data were housed in a secure, password protected account housed on EU servers (in line with GDPR requirements) and managed by the HEI.

When considering participation in the study and students feeling able to officially opt out, the researcher explored the concepts of both structural functionalism and virtue ethics as possible influencing factors. Structural functionalism describes how society interacts and functions. It describes society as a complex system whose parts work together to promote solidarity and stability (Burnham, 2018). It asserts that lives are guided by social structures, which are underpinned by established patterns and social norms. It could, therefore, be argued that students elected to undertake the study partly as a way of maintaining stability and compliance as part of their educational contract with the university. In addition, despite being given multiple reassurances that opting out would not affect their learning experience, the researcher is aware that by being responsible for both the module delivery as well as conducting the study, students may have wanted to be seen as supporting the work and acting in solidarity with the researcher and module delivery team. Furthermore, students' may have felt morally or ethically obliged to participate as they were invested in both the module as a learning opportunity as well as the well-being of the tutor. Students may have felt that participating was the 'right thing to do' and would enable the module to flourish.

At each point of data collection any students who did not attend were contacted and asked if they wished to opt-out of the study; with a clear statement there was no obligation to continue. Many students who did not attend the data collection subsequently asked for an alternate time to undertake them. However, some students indicated that they wished to remain in the study but did not attend for the rescheduled data collection. The researcher, in discussion with her supervisors, elected not to revert those students to traditional teaching, in line with the original research proposal, as they had not officially withdrawn from the study. It was felt that students should be given the choice about reverting to traditional L&T methods in light of them not wishing to undertake the data collection. However, it was felt that this should not be imposed. On reflection, underpinning this decision was the desire to ensure that not only were the students not placed at a disadvantage, but they were given the choice as to what L&T method they would prefer. The rationale for these actions was to ensure that the students felt empowered to make a decision about their L&T experience that best enabled them to flourish. The decision to maintain the status quo rather than change to traditional L&T only if the students so wished, not only minimised the disruption to the students in terms of changing study groups, it could be argued that it also aligns to the pragmatist approach that underpins much of methodology.

Students may have felt an expectation to participate when seeing that the majority of the cohort immediately consented to participate. It was therefore important to provide students with genuine choice with no repercussions. All students who did not attend a data collection exercise identified, when contacted, that they would prefer to continue receiving the L&T approach that included the learning technologies, rather than revert to traditional teaching alone. At no point did any student withdraw consent from the study. As a result, only complete data sets from the qualitative data collection stages were included in the study's findings.

Students electing not to attend the data collection exercises were still given access to the self-assessment questionnaire for personal use. It was an established optional tool for preparation for clinical placement and identification of on-going CVR learning needs. Therefore, removal of this opportunity could be seen as withdrawal of established practice and could pose a disadvantage to those students who elected not to participate in the data collection exercises.

In summary, University ethical requirements were met in relation to beneficence and non-malfeasance, informed consent, integrity, impartiality, confidentiality and anonymity. Consideration has been given to the factors that may have influenced participation, with reasons for ethical decisions articulated.

4.8.2 Reflexivity

Reflexivity within research is the process of continual critical self-evaluation of the researcher's frame of reference and positionality, with particular respect to the research process and outcome. Reflexivity aims to monitor any effects and improve the credibility of the findings by accounting for researcher values, beliefs, knowledge, and biases' (Berger, 2015; Cutcliffe, 2003). Reflexivity therefore challenges the notion that knowledge production is independent of those studying it; and accepts that, through their adopted ontological / epistemological stance, the researcher is likely to influence the research.

It is widely accepted that researchers bring their own values, expectations and interpretation to their research (Burns and Grove, 2010). However, the researcher's positioning is likely to be influenced by a range of personal characteristics including: gender, race, political and or social affiliation, age, sexual orientation, personal experiences, linguistic tradition, beliefs, biases and preferences (Berger, 2015; Bradbury-Jones, 2007). Berger, (2015) categorised the factors that may influence the research process into three areas: the field, the relationship and the worldview. These are considered in turn in the following section. At regular points throughout the study the researcher reflected on her own positionality. This was facilitated to greater extent during the video analysis process outlined in section 4.9. In addition, the researcher made regular notes during the study, which were discussed with her supervisory team during meetings. Support and facilitated reflection were also sought from peers who had experience of qualitative research.

4.8.2.1 The Field

The field in the context of this study is the students undertaking the second year CVR module. The qualitative component of the study required students to volunteer their time for focus groups or answer open ended questions within the module evaluation questionnaire. Recruitment to the focus groups was by email invitation to all students sent via the module's virtual learning environment, articulating aims and stressing voluntary participation. No remuneration was offered for either attendance or travel in order to avoid incentivisation. Refreshments were provided during the focus groups. The request for participation in the focus groups was delayed until completion of the module and was subsequent to the release of marks and feedback for the summative tasks. The reasoning was to avoid the potential for the request to be seen as coercion.

It is acknowledged that some participants may have been more forthcoming as they perceived the researcher as being invested in their educational success and hence wanted to reciprocate; knowing that this was being undertaken for a doctorate study. On completion of the first iteration of the module, volunteers for focus group participation were very forthcoming and expressed interest in contributing to increasing the understanding of the learning experience as a result of the changes to the module. In the second year of the study there had been changes to the timetable resulting in increased teaching and assessment of other modules at the time when the previous year's focus groups had been scheduled. Whilst a call for participants was circulated in Year 2, there were no volunteers forthcoming; the consequences of which are discussed in section 7.5 about study limitations.

4.8.2.2 The Relationship

In any study, the researcher-participant relationship has the potential to influence behaviours and even information participants are willing to share (Eide & Kahn, 2008).

As discussed in section 3.3, this study arose following a student-led re-design of the CVR module within the undergraduate physiotherapy programme in conjunction with the Module Lead responsible for oversight and the delivery of the L&T. It was the re-design that led the module lead to question whether the changes would impact on student learning and experience. This led to the module lead taking on the role of researcher. It is therefore important to consider how the researcher-participant relationship may have been affected by this.

Despite students electing not to participate in the data collection exercise, the self-assessment tool was still made available to all students, as it was an established optional tool used for preparation for clinical placement and/or the identification of on-going learning needs in the field of cardiorespiratory physiotherapy. Therefore, removal of this opportunity could be seen as withdrawal of established practice and could pose a disadvantage to those students who elected not to participate in the data collection exercises.

4.8.2.3 The Worldview of the Author

Personal, professional and societal experiences will undoubtedly have affected the lenses through which I viewed my research. The origins of the study were driven by my desire to improve the student learning experience and better prepare them for CVR Physiotherapy: a specialism I am passionate about.

Throughout my career I have been engaged in CVR Physiotherapy education and have always sought new ways to engage and further the understanding of colleagues and students within this field. However, my worldview runs deeper than just my clinical practice. My role for many years as Union representative and Staff Side Chair represent my wider desire to demand and defend social justice and equality; and can be argued as influencing my approach to constructing knowledge and eliciting the voices of those not often heard. It is my awareness of my biases that enables me to reflect on and, in the case of video analysis of the focus-groups, actively observe my behaviours and minimise the impact they have on my interpretation of views expressed by participants.

As previously discussed, the teacher-student dynamic and the potential for structural functionalism to have influenced the students' decision to take part in the study as a whole, as a means of pleasing the researcher, was something of which I was aware. It was therefore important to me that participants did not feel they were participating as a further means to support the researcher's endeavours, but that they were entering into a dialogue where their genuine views were sought and respected. The desire to ensure their voices were genuinely heard could therefore be argued as aligning to the aforementioned virtue ethics.

It is impossible to ignore that the involvement of the researcher in the delivery of the module's L&T would raise the student's awareness of the module being a research project and hence possibly being seen as 'trying something new'. In addition, students feeling that their L&T experience was of importance to the researcher is likely to foster a positive teacher-student dynamic; with arguably the students being invested in the research being a 'success'. However, the researcher wanted to ensure that students taking part in the focus groups were able to voice their experiences freely; with areas of the module that received negative feedback being explored equally. As previously outlined, the researcher only loosely followed the topic guide as it was important that participants shaped the emphasis and direction of the conversation.

4.9 Qualitative Data Analysis

This section explains how the focus group data were analysed. It describes how video material was integrated into the analysis process to create a new method of analysis. This novel approach of adapting known visual research methods with traditional audio transcription and inductive thematic analysis will be considered against the standards for judging the quality of qualitative research.

4.9.1 Thematic Analysis

There are a number of possible approaches to qualitative data analysis: constant comparison, discourse analysis, framework analysis and thematic analysis to name but a few: each with their own processes and merits relative to the research context (Denzin and Lincoln, 2008). Constant comparison is a process that requires the research to oscillate between the similarities and differences within an emerging theme. It is often associated with the Grounded Theory method (Charmaz, 2014); however, Leech and Onwuegbuzie (2008) identify it as an effective analysis method for focus groups. Discourse analysis focuses predominantly on the use of language in a social context (Salkind, 2019), not the spoken words themselves, so this was not considered relevant for this study.

Thematic analysis is one means by which qualitative data can be analysed and interpreted in order to identify patterns and create meaning (Clarke and Braun, 2013, Pope and Mays, 2005). It is seen as a method that provides structure whilst also acknowledging the need for flexibility in qualitative research (Clarke and Braun, 2013). However, it is this flexibility and lack of a singular defined process that means it can be seen as lacking transparency and hence rigour (Braun and Clarke, 2006). Thematic analysis can take a number of different forms, but fundamental to any of these is the epistemological approach of the researcher. Inductive thematic analysis is based on the premise that the themes are identified from the data. Conversely, framework, theoretical or deductive thematic analysis is driven by the underpinning research questions, with the data generated being mapped to predetermined overarching themes (Hayes and Hayes, 1997). As perspectives of students were being sought to inform objective three of the study, it was felt that an inductive thematic analysis would be preferable to a deductive approach in order to ensure the views of the students were appropriately represented, rather than being linked to a priori themes. Whilst this assertion aligns to the philosophies of the researcher and is appropriate for the purpose of informing objective three, it could be argued that within a sequential explanatory mixed method approach, a deductive thematic analysis approach should have been undertaken in order to better inform the quantitative findings. However, as the focus groups were undertaken prior to any quantitative analysis, it would not have been possible to use the results from the quantitative data sets to inform or pre-generate any such the themes.

Emergent topics are usually formed by the researcher identifying, highlighting and coding key areas of discussion or particular words or phrases (Burns and Grove, 2010).

Themes are identified once the researcher deems them to be of significance; and whilst many of the themes are generated based on the frequency of which they are discussed, it is not frequency alone that dictates creation of a particular theme (Morse and Richards, 2002). Therefore, fundamental to qualitative data analysis is the mechanism by which rich data are captured.

4.9.2 Video Analysis of Focus Group

Within focus group discussions this is usually via audio or video with supplementary notetaking from the researcher or assistant moderator (Kreuger, 1998). Standard practice appears to be the use of audio recording for focus groups (Morse and Richards, 2002) with some of the literature cautioning against the use of video as a means of data capture due to the potential for participants to feel self-conscious (Kreuger, 2014). For the purpose of this research study the researcher decided to use video capture, with additional audio capture as a back-up. Whilst this was unusual at the time, videoing of focus groups is now commonplace (Denzin & Lincoln, 2008).

Consideration was given to the position of the camera to ensure it was minimally obtrusive whilst also being sufficient to capture to conversations and actions of the group. All participants consented to the use of video, voicing no concern for its use. This apparent lack of concern for the use of video may have been in part due to the frequent use of student-generated videos within the module, normalising its presence. Alternatively, the acceptance of the use of video may have been influenced by society's engagement with video material and the sharing of such media which is now commonplace.

Participants were invited to take part in the focus group discussion whereby verbal consent was sought on attendance for the use of audio and video recording. Each of the focus groups was video and audio recorded from the icebreaker activity through to conclusion of the discussion. A written summary of the discussions was then generated by the researcher. Much of the literature about focus groups identifies that either verbatim transcription or a detailed summary is appropriate (Burns and Grove, 2010). However, there is a paucity of information as to what constitutes a detailed summary and, with the exception of verification from others, how such a summary is created without omitting key detail. Data from the focus groups for this study were collected; with a tape/video-based analysis (Kreuger, 2014) planned as the means of summarising discussions and to form the basis of the analysis process. The decision not to have a formal note-taker as part of the focus group interviews is discussed in section 7.5.

On conducting the initial focus group, the researcher realised that the discussions were two-way dialogue and as such the researcher was immersed within the discussions. The original intention was to take notes during the focus groups but shortly after commencing with this it became clear from students' expressions that they felt they were being 'studied'; and making notes also interrupted the easy flow of conversation and led to key observations being missed. This then limited the ability to take notes without affecting the dialogue. A decision was made to stop notetaking and refer back to the video recording. As part of the verbal consent gained at the outset of the focus groups, students were made aware that the video may be used to aid analysis purposes. No student voiced concerns or objected to the videoing of discussions.

The decision to use the videos retrospectively to observe behaviours that has influenced the approach to analysis and, in the researcher's opinion, provided a much richer interpretation of the focus group discussions and facilitated both analysis and theoretical data saturation to be reached. Rich data within qualitative research expresses the complexities of what is being reported or observed (Moser & Korstjens, 2018). Rich data can be identified through repeated and iterative analysis (Gibbs et al., 2007). Using video recordings to support the analysis enabled this repeated observation and iterative analysis. This approach was discussed with the researcher's supervisors and the development of this approach featured heavily in discussions with the independent rapporteurs at the application for confirmation of PhD viva. Ethical approval was upheld by the RF2 rapporteurs with recommendations by the rapporteurs to develop the video analysis methodology further (Appendix 9).

The initial approach to thematic analysis followed standardised practice of familiarisation (Denzin and Lincoln, 2008; Tashakkori and Teddlie, 2010; Burns and Grove, 2010) where the researcher watched and re-watched the focus group videos, the plan being to make detailed summary notes of each of focus group. The use of a detailed summary was a novel approach to the researcher, and indeed ascertaining the levels of detail required was challenging due to the paucity of available guidance. The videos were used as the basis for transcription / summary writing and hence the researcher was required to watch and re-watch small sections in order to construct a detailed summary. These sections were clustered around a particular question or discussion and varied in length.

It was during the generation of these summaries from the video footage that the researcher realised that the nature of interactions and behaviours both of the participants and the researcher needed to be captured in order to make sense of the narrative. Initially, these were part of the narrative summary. However, it became challenging to identify and decipher. As a result, a systematic and staged approach was taken considering different elements in turn. This staged approach facilitated the development of a template (Table 4.7) to capture and articulate what was observed. The first stage involved summarising the verbal discussions in response to the questions and probing form the researcher. Within this stage emerged the need to identify representative quotes for each summary; this precipitated column three of the template.

Following transcription and summary formation, the identification and coding of key words or phrases is required as part of the inductive thematic analysis process (French, Reynolds and Swain, 2001; Denzin and Lincoln, 2008; Tashakkori and Teddlie, 2010; Burns and Grove, 2010). This process facilitates the identification of the topics discussed. In order ensure appropriate detail was captured within the summaries, strength of agreement or disagreement amongst participants in relation to the topics being discussed was identified. The use of video analysis provided opportunities to consider nonverbal communication and its role in providing context to the feelings of the participants.

Nonverbal communication can take many different forms: facial expressions, eye contact, gestures, paralinguistics, body language and posture (Wood 2006). Through the use of video analysis, it was possible for the researcher to observe and revisit the nonverbal communication of the participants, summarising these as well as verbal interactions. It was this dimension and the ability to revisit this through watching and re-watching the video that provided an additional dimension to the analysis. Too often, thematic analysis relies on verbatim transcription and the identification of words or themes based on verbal articulation alone. This approach can be enhanced by observer notes taken during the focus groups themselves; however, these rely solely on real-time observations. Whilst it is possible to revisit the notes taken, it is not possible with this approach to revisit the interactions or observed behaviours themselves. However, utilising video analysis to systematically observe each participant's nonverbal communication in each section, the researcher was able to derive further meaning to enrich the summary.

It could be argued that the accuracy of the interpretation of nonverbal communication is dependent on the skills that require training and development (Onwuegbuzie, Dickinson, Leech, & Zoran, 2009). As an experienced clinician and educator, the researcher has been required to observe and respond to situations on a daily basis throughout a professional career that to date spans over two decades. The nature of these professional roles ranges from communicating sensitively to patients, their parents and families about end of life wishes and decisions, to leading and managing a team and providing pastoral support to students experiencing personal challenges. The skills required to undertake these roles have arguably required the researcher to be able to read the behaviours, nonverbal communication and responses of others in order to navigate situations carefully. Whilst it is acknowledged that formal training in the analysis of body language and nonverbal communication was not sought for the purpose of this study, it is believed that the researcher's pre-existing skills enabled basic nonverbal communication observations and appropriate inferences to be made. This is discussed further within section 7.7.2.1.

As previously discussed, reflexivity is said to be when a researcher demonstrates awareness of the relationship between themselves, the participants, the data generated and their method of analysis (Mills, Durepos and Wiebe, 2009). It is therefore important to ensure transparency and reflexivity wherever possible during the process of analysis. To this end, a further stage of analysis was incorporated. After completing the summary and extraction of key quotes, followed by observing the nonverbal communication and interactions of the participants, the researcher re-watched each section and this time noted her own behaviours and nonverbal communication. Whilst this may have the least influence on the inductive analysis stage, it is important as it enabled the researcher to reflect on her role during the process.

Impressions about each section were noted using key words arising from that discussion. Then, an attempt was made to quantify the researcher's perceived strength of feeling surrounding that discussion. This was categorised with one, two or three 'plus' icons, to indicate a positive experience; with one plus being the weakest and three being the strongest. Similarly, negative experiences were depicted by one, two or three 'minus' icons. This final column influenced the codification the least but provided the researcher with the ability to articulate her own perceptions of the relative weight and importance of each section. Once this process was complete for each of the focus groups, the researcher reviewed the key word / emergent theme column, highlighting similar key words and identifying emergent themes.

It is recognised that this approach is previously untested in this context, although visual methods within sociology and anthropology are well documented (Denzin & Lincoln, 2008; Pauwels & Margolis, 2011) Further work to standardised, evaluate and refine it is required to demonstrate its relevance and value as an analysis method in its own right. This is discussed further in Chapter 7.

Table 4. 7 Blank template developed for video analysis of focus group discussion

Researcher question / prompt	General summary	Stand out participant quotes	Observed behaviours of participants	Observed behaviour of researcher (R)	General notes, comments or impressions	Key words / emergent themes	Perceived strength of feeling

4.10 Summary

The core themes of clinical reasoning within physiotherapy practice; physiotherapy educational approaches; and the student learning experience influenced the choice of study aims and research questions. This chapter provided rationale and justification for the methodological and philosophical underpinnings of this study. Assessing student knowledge, understanding and clinical reasoning following the redesign of the module, was underpinned by an ontological philosophical stance. However, gaining insights into the perceptions of Physiotherapy students of their own ability as well as their overall learning experience meant the philosophical stance was situated towards the relative end of the spectrum.

Pragmatic methodological decisions pertinent to the study aims and the constraints of the module in which this study is situated, was also provided. There was a detailed description of the method implemented, with consideration for the relevant mixed methods typology in the context of real-world research.

Mediation of variables, ensuring rigour and the reflexivity of the researcher were considered, as well as a range of ethical perspectives. Consent and the role of societal factors and theories, such as structural functionalism were also explored. A summary and critique of the outcome measures used was provided in addition to an overview of the sampling strategy employed.

The final section of this chapter introduced a novel approach to focus group analysis using a visual iterative method of thematic analysis that contributes new knowledge to the field of research methodology and warrants further development.

CHAPTER FIVE: RESULTS

To maintain the core narratives in the study, the results drawing from the different data sets are deliberately clustered around each of the main study questions. The first section however provides demographic details about the participants.

5.1 Demographics

Personal and educational demographics of all students enrolled on the study are outlined in Tables 5.1 and 5.2; with focus group participant details presented in Table 5.3.

At the time of writing, gender inequalities are of high profile across society in terms of opportunity, representation and learning potential (Olson, 2013). Whilst none of these issues are of direct influence in the context of this study, it should be noted that 52% of the study cohort were female. Also noticeable is the limited range of ethnic origin with only 14% of the cohort being from Black, Asian and minority ethnic (BAME) backgrounds. This should be borne in mind in relation to the potential lack of diversity, unconscious bias and the lack of peer and role model support; and the potential impact this may have on attainment for those students from BAME backgrounds (Miller, 2016).

Table 5.1 Summary of student demographics

Study cohort	Number of students	Gender	BAME (% of cohort)	Disclosed disability (% of cohort)	International (non-EU) students
Year 1	103	48 (f) 55(m)	9 (9)	27 (26)	3
Year 2	84	50 (f) 34(m)	16 (19)	8 (10)	12
Total	187	98 (f) 89(m)	27 (14)	35 (19)	15

Age of students was deemed an important demographic for inclusion (Table 5.2). There are wide-held perceptions in some areas of society that younger generations possess greater knowledge and skill in the use of technology (Napoli and Ewing, 2000). However, the assumption that students are comfortable with using technologies in a learning context is being challenged more widely across the sector (Kennedy, et al, 2008) and indeed it was something that the researcher was keen to understand. Whilst it was not possible within this study to pair the module evaluation comments with the student demographics, understanding the study cohort in relation to age, and specifically those of the focus group participants, enabled greater consideration as to the link between age and perceptions of the value or disruptive nature of technology in the classroom. When designing L&T resources, consideration was given not only to the underpinning pedagogy in how the activities and resources are structured, but also the accessibility of the resources being created. This was to ensure the format of resources and compatibility with different accessible software, for example screen-readers. As can be seen in Table 5.1, 19% of the study cohort disclosed a disability; this ranged from dyslexia, to hearing impairments, physical disabilities and mental health needs.

Previous educational experience and qualification is included as it is known that students from non-traditional educational backgrounds can have a very different experience of Higher Education (Testa and Egan, 2014). Non-traditional educational backgrounds and entry qualifications, for this study, encompass any non A/AS-level study or preceding UK UG degree. Exploring perceptions of L&T was integral to the research aims of this study so awareness of the range of educational backgrounds and experiences offered insight into trends and assertions. As can be seen from Table 5.2, approximately one third of the study cohort was not from traditional A/AS level educational backgrounds.

Table 5.2 Summary of student pre-entry study profile

Study cohort	Mean age on module completion (SD)	Mature* students (% of cohort)	Non-standard** educational entry qualification (% of cohort)	Break in study before course entry*** (% of cohort)
Year 1	22.1 (4.1)	27 (26)	28 (27)	26 (25)
Year 2	23.1 (6.7)	30 (36)	36 (43)	29 (35)
Total	22.6 (5.8)	57 (30)	64 (34)	55 (29)

*Mature defined as >21 years old on commencement of the UG Physiotherapy programme
** Non-standard educational entry qualification defined as any recognised qualification not A/AS level.
*** Number of students who had a break in study of greater than 1 year between completion of preceding programme of study and commencement of the UG Physiotherapy programme

Table 5.3 outlines the demographics of the focus group participants where design and accessibility of resources were explored in more depth. It is worthy of note that over 50% of the focus group participants had disclosed a disability.

Initially, the impact of and relationships between these external factors were not explored specifically within the study; however, these factors gained more significance to the researcher when trying to understand better the assertions made by the focus group participants. This was coupled with a heightened awareness from publications across the sector as to the role these factors may have on expectations and outcome within Higher Education (Stevenson, 2012; Gourlay and Stevenson, 2017)

Table 5 3 Summary of focus group demographics

Focus group	Number of participants	Gender	Mean age (years)	Disclosed disability
1	5	3 (f) 2(m)	25.1	N= 3
2	5	1 (f) 4 (m)	29.0	N=3
3	3	3 (f) 0(m)	20.3	N=1

All students undertaking the module over the two iterations agreed to take part in the study from the outset, completing a written consent form following receipt of information about the study both verbally and in written form, and following opportunities to ask questions. As can be seen from Table 5.4 there were non-attendance at one or more data collections points for MCQ and self-assessment data sets. As these two data sets were collected at the same time, non-attendance meant neither data set was collected.

One of the most apparent factors that affected attendance at the MCQ and self-assessment data gathering points was timing. Whilst it is impossible to account for all eventualities, it was noted that one data collection point happened to be scheduled the morning after an organised evening social gathering. This accounted for many non-attendees for Year One's intervention groups 1 and 2. With the exception of this particular incident, engagement with the study and data collection exercises appeared to be consistently positive. Only full data sets were used when analysing the data.

Table 5. 4 Initial sample size and complete data sets for MCQ and self-assessment data

Intervention group	**Student group size and number of complete data sets for module marks**		**Number of complete data sets for MCQs and self-assessment**	
	Year 1	Year 2	Year 1	Year 2
1	33	30	25 (-8)	27 (-3)
2	35	25	21 (-14)	20
3	35	29	31 (-4)	25
Total	103	84	77	72

5.2 Impact on Knowledge and Understanding

Research question one investigated whether the inclusion of learning technologies and video-based resources have a greater impact on knowledge and understanding than traditional teaching methods. As outlined in Chapter 4, a range of quantitative data was collected as a means of identifying the level of learning relative to each type of L&T intervention. MCQ data were collected as a baseline prior to the start of the module teaching, then after each L&T intervention. Participants completed twenty-five questions randomly selected from a pool of 135 at each data collection stage; with one point awarded for a correct answer (Appendix 11). There were three data collection stages: baseline; following first L&T delivery; and after crossover L&T delivery. It was anticipated that there would be a significant increase from the students' baseline knowledge to those scores following the first L&T delivery in light of this being their first formal teaching in Cardiovascular-Respiratory Physiotherapy. However, of interest was whether there was any significant difference between the L&T interventions and the relative gain following crossover. Therefore, between group analysis was key to this. Figures 5.1a, 5.1b, 5.1c denote mean scores for each intervention group at each stage of the data collection: baseline, following the initial L&T intervention and post crossover delivery. Tables 5.5 and 5.6 indicate mean scores for each cohort.

Figure 5.1a, b and c. Bar charts representing average MCQ marks at each stage of data collection per intervention group; for year 1, year 2 and combined data sets respectively

5.1a Year 1 MCQ scores 5.1b Year 2 MCQ scores 5.1c Combined MCQ scores

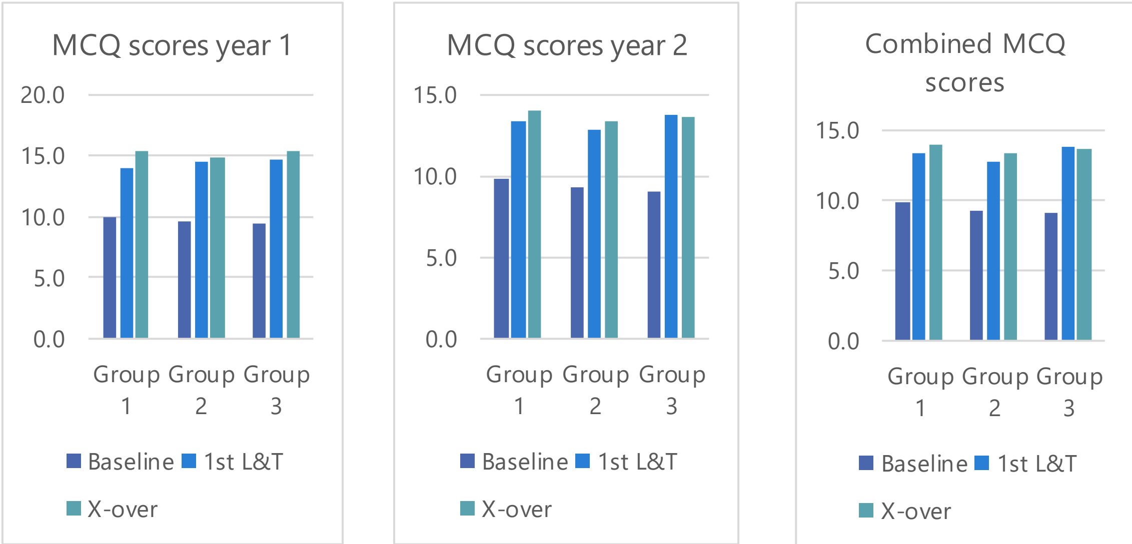


Table 5.5 Mean and standard deviations for Year 1 MCQ data. Standard deviations are denoted within parentheses

	MCQ		
Intervention group	Baseline	Repeat	Final
1	10.0 (2.6)	14.0 (3.6)	15.5 (2.4)
2	9.6 (2.4)	14.5 (3.9)	14.9 (3.1)
3	9.5 (2.4)	14.7 (3.2)	15.42 (3.1)

Table 5. 6 Mean and standard deviations for Year 2 MCQ data. Standard deviations are denoted within parentheses

	MCQ		
Intervention group	Baseline	Repeat	Final
1	9.9 (3.0)	13.3 (2.8)	14.0 (3.1)
2	9.3 (3.2)	12.8 (3.2)	13.4 (2.9)
3	9.1 (2.6)	13.8 (3.2)	13.6 (2.9)

The results show educationally and statistically significant improvements from baseline MCQ to initial intervention for all cohorts ($p<0.001$). However, on performing a one-way ANOVA there is no statistically significant difference between the amount of knowledge gained relative to the intervention group and hence L&T approach utilised. So, despite Tables 5.5 and 5.6 and Figures 5.1a, 5.1b, 5.1c indicating that the traditional L&T group had the smallest initial gain from baseline and the largest final MCQ score, the gains are not statistically significant: Year one: $F(2,74)=0.87$; $p=0.421$; Year 2: $F(2,69)=0.12$; $p=0.887$; Combined data sets: $F(2,146)=0.89$; $p=0.411$.

It can also be seen, however, from Tables 5.5 and 5.6, that the additional difference in MCQ scores following crossover is negligible. Not surprisingly, this knowledge gain was neither educationally nor statistically significant. Year one: $F(2,74)=0.18$ $p=0.836$; Year 2: $F(2,69)=0.04$; $p=0.960$; Combined data sets: $F(2,146)=0.17$; $p=0.842$. This lack of significant additional improvement in knowledge following the revisiting of topics appears to contradict the assertion that topics need to be revisited to be understood more fully. An influencing factor in the re-design of the module was student feedback about the difficulty in understanding certain topics and hence the importance of revisiting them.

These results showing minimal differences in additional knowledge gain bring into question the merit of revisiting a given topic per se. The lack of additional learning demonstrated by the MCQ data can be interpreted in several ways. The main considerations from these findings include the sensitivity of the measure used, the potential for students to continue to utilise the L&T resources originally provided, and the design of the cross-over element. The implications of these results in relation of perceived value by students are discussed in Chapter 7.

5.3 Impact on Clinical Reasoning in the Field of CVR Physiotherapy

Research Question Two investigated whether the module redesign improved students' Clinical Reasoning in the field of CVR Physiotherapy. To ascertain this, the module's assessment marks were used. As outlined in Section 2.2.6.2 the assessment for the module consisted of a practical task and a written assignment, both based around clinical cases, to assess students' ability to assess and clinically reason in a given situation. The module assessment mark data were analysed in two ways: the module marks from the CVR module were compared against the other specialism module marks (MSK and Neuro) that ran concurrently; and the module marks from the two cohorts participating in the study were compared to the marks awarded to previous cohorts undertaking the same tasks, but prior to redesign. By considering the data in this dual way, an informed judgement can be made as to whether the module redesign improved clinical reasoning within the field of CVR and the presence of a cohort effect.

5.3.1 Comparison Across All Three Level 5 Specialism Modules

Table 5.7 provides a summary of marks across the three specialism modules in the year preceding the study. One-way ANOVA comparing the three level 5 core specialism modules: musculoskeletal (MSK), neurological (Neuro) and cardiovascular-respiratory (CVR) demonstrated a significant difference between mean module scores: $F(2,246)$ 6.8; $p=0.001$, with post-hoc Tukey's testing indicating the relative significance between each of the module marks (Table 5.8).

Table 5. 7 Summary of module marks for each of the specialism modules for the cohort preceding the study

Module	Mean	Median	SD	95% Confidence Interval	
				Lower	Upper
CVR	58	60	10.53	55.95	60.55
MSK	65	64	12.36	62.29	67.69
NEURO	62	62	12.27	59.21	64.57

Table 5. 8 Between group analysis of preceding cohort marks across the three specialism modules

Tukey's Multiple Comparison Test	Mean Diff.	p
CVR vs MSK	-6.73	<0.001
CVR vs NEURO	-3.63	0.021
MSK vs NEURO	3.09	0.026

Whilst assumptions about the difference between module marks should be viewed with caution, as they are only based on one cohort's set of data, the module mark data (Table 5.8) represent both an educational and statistically significant difference in the level of student attainment, particularly in relation to the mean scores for MSK compared to CVR, with the CVR marks being more than 6 percentage points lower on average. This may offer some explanation as to why students believed the CVR module to be more difficult than the other L5 specialist modules. However, as these modules were validated by the HCPC and deemed to be of equivalent level, even using comparable marking criteria, an explanation of this difference in marks could be that the content within level 4 of the programme being predominantly MSK and Neuro provided a better grounding in those two specialisms on which students could consolidate and build their clinical reasoning skills within level 5. Hence, students achieved proportionally higher marks in those specialism modules.

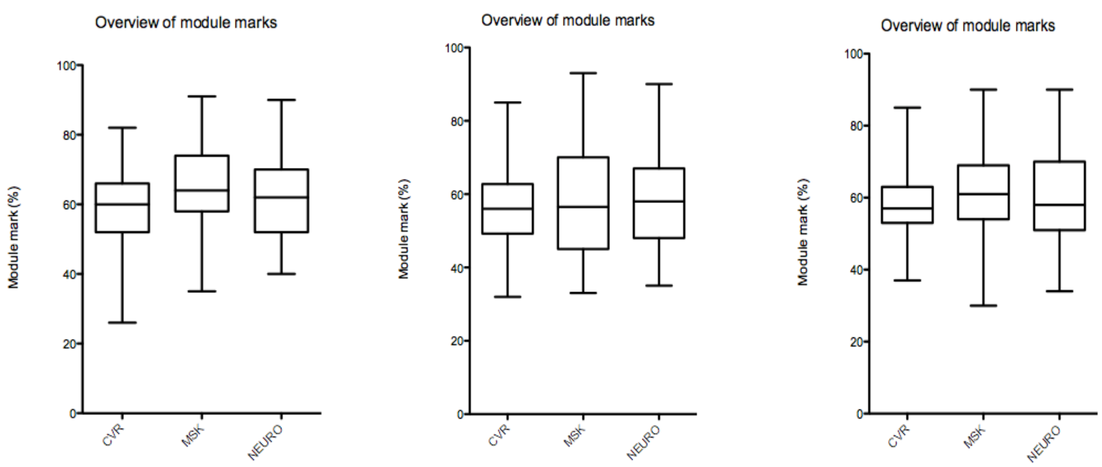
When analysing the module marks from the two student cohorts participating in the study, the module marks across all three Level 5 modules were lower, but comparable. This convergence towards the same mean module mark offers some reassurance that changes in module assessment marks are not attributable to the cohort effect alone. Presence of a cohort effect alone would arguably not result in a convergence of module marks, rather a shift upwards or downwards, with the relative difference between the specialisms still present. Figure 5.2 provides an overview of student marks for the year preceding the study (5.2a) and the two subsequent study cohorts (5.2b and c respectively)

Figure 5. 2 Box and whisker diagram of student marks for both the study's module and the additional two 20 credit, clinically based modules undertaken concurrently

5.2a: Cohort marks prior to study

5.2b: Cohort marks Year 1 of study

5.2c: Cohort marks Year 2 of study



Whilst these results do not demonstrate that there was an increase in demonstrable clinical reasoning because of the curriculum redesign, a statistically significant difference between the MSK specialism module is no longer present.

5.3.2 Comparison of Cardiovascular-Respiratory Module Marks

At the outset of the study, it was identified that to demonstrate a significant improvement in clinical reasoning, module marks for CVR would need to improve by four percentage points to elevate those students within the top half of a particular marking band into the next higher banding. As can be seen from Table 5.9, there does not appear to have been a significant educational improvement compared to the mean scores of the preceding cohort in CVR, following the redesign of the module. Initially module marks were analysed using one-way ANOVA to identify any potential significant difference across the different intervention groups in demonstration of clinical reasoning as assessed by academic staff. Results showed no different in clinical reasoning across the three intervention groups: Year one F(2,74)=0.64, p=0.532, Year two F(2,83)=2.19, p=0.118

Further analysis of the data was undertaken, comparing module marks to previous cohorts to identify if overall achievement against educational outcomes was greater. Table 5.9 provides a summary of four cohorts' module marks for cardiovascular-respiratory: two cohorts preceding the study and the two cohorts within the study.

Table 5. 9 Cardiovascular-respiratory module marks for the two cohorts preceding the study and the two study cohorts

Student cohort	**N**	**Mean**	**Median**	**Std. Deviation**
Previous cohort 1	88	59.34	59.50	8.66
Previous cohort 2	82	62.60	58.29	10.12
Year 1 study cohort	103	58.88	55.04	13.47
Year 2 study cohort	80	58.42	57.25	9.87

As can be seen from Table 5.9 there is a slight reduction in marks for the study cohorts when compared to previous iterations of the module. These results, if taken in isolation, could call into questioned whether the study was impacting negatively on student attainment. However, this reduction in average mark is not statistically significant. Furthermore, when considering the cohort marks relative to the other specialism modules, there was a convergence of marks across the three specialism modules during the study (Figure 5.3). The reduction in marks during the study is therefore of less significance; and is a smaller reduction in average mark than observed within the other specialism modules. This result arguably indicates a greater proportional attainment within the CVR module. However, due to the lack of statistical significance it is not possible to state that the module redesign significantly improved the clinical reasoning of students within the field of CVR. Consideration of these results in light of the module's approach to the assessment of clinical reasoning will be provided in section 7.2 of the discussion chapter.

5.4 Impact on Self-Assessment of Clinical Ability

To ascertain whether the inclusion of learning technologies and video-based resources impact positively on student's perceptions of clinical ability when compared to traditional teaching methods, a validated self-assessment questionnaire was used. As outlined in section 4.6.2. students were asked to rate their level of perceived competence across assessment, problem identification and treatment planning in the field of cardiovascular-respiratory physiotherapy. A five-point Likert scale was used to rate the level of confidence against a given competence statement; with one point awarded for the least confident rating, five points for the most confident. There were 60 statements to rate as well as a section on clinical experience within the field of cardiovascular-respiratory physiotherapy. The latter did not carry any marks and hence it was exempt from the scoring. A maximum score of 300 could be achieved if an individual strongly agreed with each competency statement. Conversely, the lowest possible score was 60.

Due to the sequential grading of the levels of agreement within the scale, and the perceived magnitude spacing between each level, the data produced have been determined to be interval in nature (Harwell and Gatti, 2001). The self-assessment of clinical competence was collected after the first L&T intervention and again after the crossover delivery. Unlike the MCQ data whereby initial raw data demonstrated a greater increase in gain for L&T approach 3 (Learning Technologies group) across both year cohorts, initial raw self-assessment data implied the reverse of this; as outlined in tables 5.10 and 5.11 and figures 5.3a, b and c. Repeat scores following the crossover intervention appeared to identify a levelling of this effect. This therefore brought into question whether the use of TEL lowered the student's perceptions of their competence; or conversely whether traditional L&T inflated an individual's perception of their level of competence.

Analysis of each group's data demonstrated a statistically significant increase in score ($p<0.001$) between the initial and the second teaching intervention. The relative gain across each intervention group was then analysed using a one-way ANOVA. Whilst initial ANOVA of year 1 data indicated that the results were not significant ($F(2,74)$ 2.69;

p=0.074), accompanying Welch testing revealed p=0.047. Post-hoc testing using Tukey's multiple comparison test (Table 5.10) was also conducted which identified that L&T approach 3, which received TEL initially followed by traditional L&T at crossover, demonstrated the largest, albeit not statistically significant, gain in their self-assessment of competence after crossover delivery when compared to the other groups. The potential here is that the traditional teaching brought about a heightened sense of clinical ability. However, year two data (Table 5.11) revealed a different picture F(2,69) 2.41; p=0.787, indicating no significance difference between any of the intervention groups, thus not substantiating this.

Figure 5. 3 a, b and c. Mean self-assessment scores for each study year, per intervention group

5.3a Year 1 5.3b Year 2 5.3c Combined scores

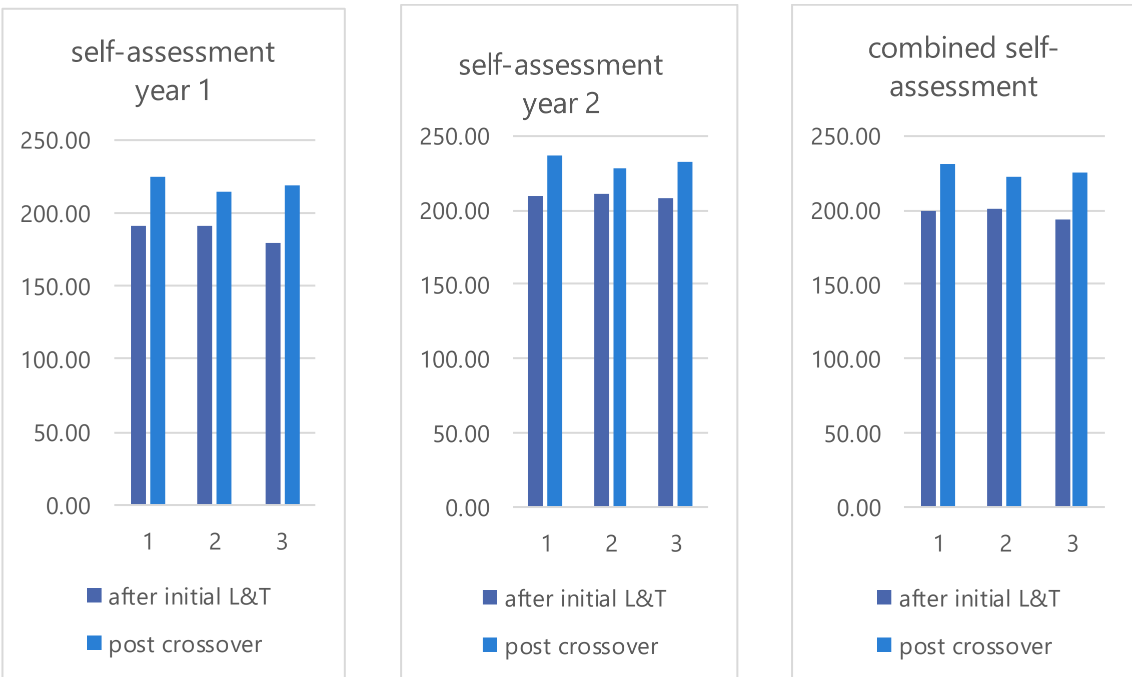


Table 5. 10 Results from Tukey's test comparing the final self-assessment scores study Year 1

Intervention group comparisons Study Year 1	Mean difference between groups' self-assessment score	p value	95% Confidence Interval	
Group 1 with Group 2	10.6	.338	-7.28	28.38
Group 2 with Group 3	16.5	.059	-0.52	33.53
Group 3 with Group 1	-5.9	.655	-10.24	22.14

Table 5. 11 Results from Tukey's test comparing the final self-assessment scores study year 2

Intervention group comparisons Study Year 2	Mean difference between groups Self-Assessment score	p value	95% Confidence Interval	
Group 1 with Group 2	10.5	0.226	-4.60	25.64
Group 2 with Group 3	-6.9	0.522	-22.00	8.22
Group 3 with Group 1	-3.6	0.813	-17.70	10.48

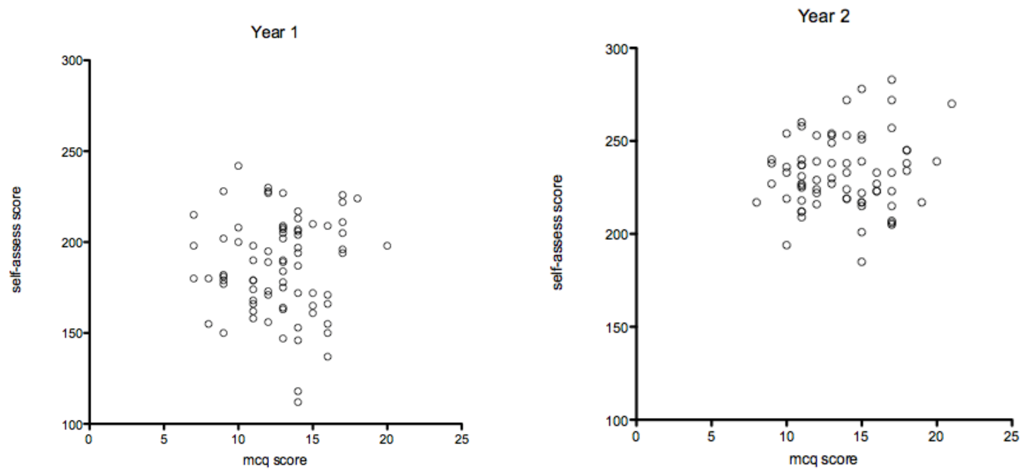
It is worthy of note that whilst the relative improvement in self-assessment scores between the first and the crossover L&T intervention is comparable across all groups and years, Year 1 initial self-assessment scores appear significantly lower than those from Year 2. As discussed in Chapter 4, following completion of the module in Year 1, students requested that the self-assessment be added as a baseline measure, rather than be introduced at the point of MCQ knowledge check following the first L&T intervention. A two-tailed t-test indicated: mean year 1 self-assessment score= 186.6 ±3.05, mean Year 2 self-assessment score = 209.0 ±2.81; t5.38 (df147), p<0.0001. This statistically significant difference in self-assessment scores at the point of first L&T intervention between cohorts, however, does not appear to skew the self-assessment data in the context of this study's data analysis.

What can be seen from this analysis is that a statistically significant result was identified in Year 1 of the study between the self-assessment scores of those receiving the TEL resources and those receiving traditional L&T approaches; with those receiving TEL scoring themselves lower. This was not replicated in the second year of the study. However, the additional increase in score after crossover for those students then receiving traditional L&T approaches is worthy of note. Whilst robust conclusions cannot be drawn on these results alone, this highlights the need for further research and greater understanding of the factors that affect the self-assessment of UG Physiotherapy students in the field of CVR.

5.4.1 Comparison Self-Assessed Measures with Other Data Sets

Research has shown that there is variability in the self-assessment of novice practitioners (Baxter and Norman, 2011; Siles-González and Solano-Ruiz, 2016). As part of the sequential exploratory analysis, potential relationships between assessed and self-assessed scores were undertaken to provide greater insight. Figure 5.4 depicts the relationship between MCQ scores and self-assessment scores on completion of the module's teaching.

Figure 5. 4 Scatter diagram depicting final MCQ and self-assessment scores of students in Year 1 and Year 2



As can be seen from Figure 5.4 there is no correlation between the two measures for either study cohort. Years 1: r= 0.021, n=77, p=0.858; Year 2 r=0.13 n=71 p=0.301

As the self-assessment questionnaire focused on the confidence of the student in their cardiovascular-respiratory ability, an exploration of whether there was any relationship between self-assessment score and the simulated case study assessed by the module teaching team was undertaken. This was to provide insight as to whether a student's perception of their own clinical reasoning and ability bore any resemblance to the mark awarded by an experienced practitioner.

Figure 5. 5 Plotted self-assessment scores against assessed simulated case study (module summative assessment task A)

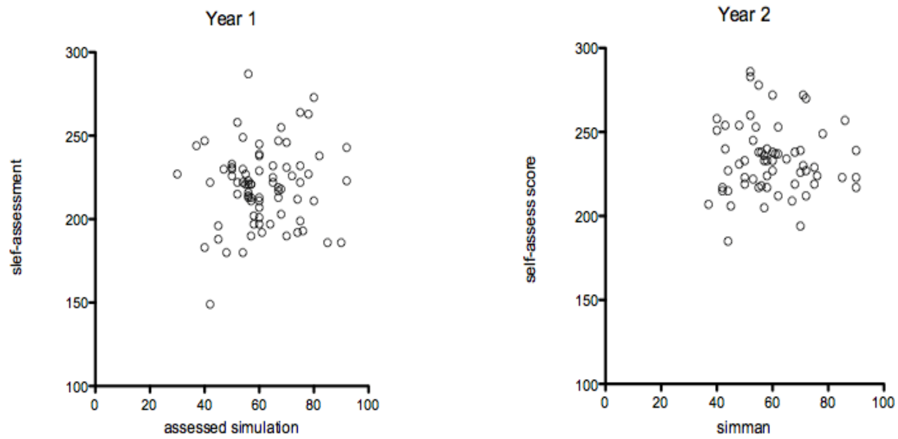


Table 5. 12 Year 1 correlation between final self-assessment and summative practical assessment task mark per intervention group

	Intervention group		
	1	2	3
Number of Paired data sets	25	21	31
Pearson r	0.30	-0.09	-0.06
P value	0.150	0.696	0.738

Table 5. 13 Year 2 correlation between final self-assessment and summative practical assessment task mark per intervention group

	Intervention group		
	1	2	3
Number of Paired data sets	24	16	23
Pearson r	0.08	-0.02	-0.16
P value	0.728	0.953	0.462

As can be seen in figure 5.5 and tables 5.12 and 5.13, there was no association between the perceived level of competence and confidence of a student and the assessed simulated scenario, marked by an experienced clinician.

When considering whether the inclusion of learning technologies and video-based resources impact positively on student's perceptions of clinical ability when compared to traditional teaching methods, these results indicate that they did not. The relevance of these findings will be discussed in section 7.2.2 in conjunction with the findings from the focus groups.

5.5 Impact on the Student Learning Experience

The fourth research question set out to explore which learning and teaching approaches had the greatest impact on the student experience.

5.5.1 Module Evaluation

As discussed previously, a modified module evaluation form was used for the duration of the study with additional questions included to elicit feedback about the specific learning technologies introduced as part of the study. Students were asked to state their level of agreement with forty-five statements about their experience of the module using a five-point Likert scale. Rather than allocate a combined score, as presented with the self-assessment data, it was decided for presentational purposes to select specific questions to highlight the spectrum of opinion about the module generally and the learning technologies specifically. Using descriptive statistics in this way enables an overarching understanding of students' perceptions. These findings are not meant to provide robust data on which conclusions can be drawn and extrapolated, but they provide a broader context for comparison and/or verification when considering the emergent focus group themes.

Presented on subsequent pages are a number of the standard module evaluation questions (Tables 5.14, 5.15, 5.16, 5.17, 5.18, and 5.24) as well as the additional learning technology-specific questions (Tables 5.19, 5.20, 5.21, 5.22, 5.23). The responses depicted have been selected as they are considered as providing the best insight into the range of student experience in terms of awareness of the module, understanding of the assessment task, content delivery, range of L&T experiences and impact on learning and development needs. As will be seen later, these are of relevance when considering the data from the focus groups.

Table 5.14 Statement 2 from the modified Module Evaluation Form

I was given an overview of the module content at the start of the module				
Response	Year 1	Year 2	Combined total	%
Definitely agree	55	47	102	53.97
Mostly agree	35	36	71	37.57
Neither agree nor disagree	3	0	3	1.59
Mostly disagree	5	2	7	3.70
Definitely disagree	6	0	6	3.17

Table 5.15 Statement 15 from the modified Module Evaluation Form

The assessment tasks were explained at the start of the module				
Response	Year 1	Year 2	Combined total	%
Definitely agree	42	38	80	42.33
Mostly agree	48	42	90	47.62
Neither agree nor disagree	6	2	8	4.23
Mostly disagree	4	3	7	3.70
Definitely disagree	4	0	4	2.12

Table 5.16 Statement 5 from the modified Module Evaluation Form

Staff were good at explaining things				
Response	Year 1	Year 2	Combined total	%
Definitely agree	60	52	112	59.26
Mostly agree	34	30	64	33.86
Neither agree nor disagree	2	1	3	1.59
Mostly disagree	2	2	4	2.12
Definitely disagree	6	0	6	3.17

Table 5 17 Statement 6 from the modified Module Evaluation Form

Staff have made the subject interesting				
Response	Year 1	Year 2	Combined total	%
Definitely agree	61	52	113	59.79
Mostly agree	32	28	60	31.75
Neither agree nor disagree	4	2	6	3.17
Mostly disagree	0	3	3	1.59
Definitely disagree	7	0	7	3.70

Table 5. 18 Statement 7 from the modified Module Evaluation Form

L&T activities helped my understanding				
Response	Year 1	Year 2	Combined total	%
Definitely agree	50	49	99	52.38
Mostly agree	43	31	74	39.15
Neither agree nor disagree	1	1	2	1.06
Mostly disagree	4	4	8	4.23
Definitely disagree	6	0	6	3.17

Table 5. 19 Statement 8 from the modified Module Evaluation Form

The video/interactive workbooks helped improve my understanding				
Response	Year 1	Year 2	Combined total	%
Definitely agree	51	40	91	48.15
Mostly agree	33	30	63	33.33
Neither agree nor disagree	11	10	21	11.11
Mostly disagree	3	4	7	3.70
Definitely disagree	6	1	7	3.70

Table 5. 20 Statement 9 from the modified Module Evaluation Form

The 3D resources helped improve my understanding				
Response	Year 1	Year 2	Combined total	%
Definitely agree	42	33	75	39.68
Mostly agree	29	33	62	32.80
Neither agree nor disagree	19	11	30	15.87
Mostly disagree	10	8	18	9.52
Definitely disagree	4	0	4	2.12

Table 5. 21 Statement 10 from the modified Module Evaluation Form

Using the iPads in sessions helped me access more resources				
Response	Year 1	Year 2	Combined total	%
Definitely agree	31	27	58	30.69
Mostly agree	36	33	69	36.51
Neither agree nor disagree	18	10	28	14.81
Mostly disagree	15	12	27	14.29
Definitely disagree	4	3	7	3.70

Table 5. 22 Statement 11 from the modified Module Evaluation Form

Using the iPads in sessions improved group activities				
Response	Year 1	Year 2	Combined total	%
Definitely agree	31	28	59	31.22
Mostly agree	35	29	64	33.86
Neither agree nor disagree	18	12	30	15.87
Mostly disagree	15	11	26	13.76
Definitely disagree	5	5	10	5.29

Table 5. 23 Statement 12 from the modified Module Evaluation Form

Using Simman helped improve my understanding of cardiovascular-respiratory assessment				
Response	Year 1	Year 2	Combined total	%
Definitely agree	62	62	124	65.61
Mostly agree	30	20	50	26.46
Neither agree nor disagree	4	1	5	2.65
Mostly disagree	0	1	1	0.53
Definitely disagree	8	1	9	4.76

Table 5. 24 Statement 41 from the modified Module Evaluation Form

The module has helped me identify my ongoing learning needs				
Response	Year 1	Year 2	Combined total	%
Definitely agree	57	51	108	57.13
Mostly agree	39	32	71	37.57
Neither agree nor disagree	1	0	2	0.53
Mostly disagree	3	1	4	2.12
Definitely disagree	4	1	5	2.65

From the learning technology-specific questions it can be seen that the majority of students agreed that each of the new approaches enhanced their learning. The use of simulation gained the strongest level of agreement (92% either mostly or definitely agreed) followed by the video resources (81.5% either mostly or definitely agreed). The use of iPads in-class to aid group work along with the 3D virtual reality (VR) resources had the least positive response; although the lowest level of agreement was still 65% (Using the iPads in sessions improved group activities) indicating most respondents still felt the inclusion of iPads to support group activities was positive. In relation to this point, consideration should be given to the timeframe in which the study was conducted. At the time of the study, SMART phones and Tablet devices, whilst increasing in popularity in society, were not widely encouraged within the classroom; with many colleagues still asking students to put away all phones as they were perceived by some as a distraction and not an adjunct to learning. The issue of how the iPads were used, and specifically the inclusion of the devices for students to direct their own use as per L&T approach 2, is raised both within the qualitative comments from the module evaluation and the focus group discussions (section 5.5.2).

5.5.1.1 Positive Module Evaluation Comments

In addition to the Likert scale responses, student comments from the four free-text areas were also collated. Unlike the Likert scale questions, these were not compulsory questions, therefore not every respondent provided additional feedback. Of the four questions: 'Please identify the three most positive aspects of the module'; 'Please identify up to three things you would like to see changed about the module (and why)'; 'Please elaborate on any questions you answered 'mostly disagree' or 'definitely disagree''; 'Is there anything else you wish to tell us about the module', the first two were of primary interest to the aims of the research; and hence were analysed in detail.

For each of the two free-text questions, statements were reviewed repeatedly to ensure familiarity and themes generated based on the type of comments. Sufficient themes were generated to ensure each item of feedback could be allocated to one of the themes. For example, comments such as *"variety"* were allocated to L&T Approach; "Simman" to Learning Technologies and "staff were enthusiastic and approachable" to Teaching staff. If an item of feedback included reference to multiple aspects on a given theme in one sentence e.g. *"I really liked the use of Simman, iPads and 3D"*, that would only be counted once and allocated, in this example, to Learning Technologies. However, if these items were specifically depicted individually, as denoted by a full stop or new line space, then these were allocated and counted individually. The frequency of comments pertaining to each theme was then collated. The most prevalent comments are outlined in Table 5.25.

Table 5. 25 Student feedback in relation to the module evaluation question: *Please identify the 3 most positive aspects of the module*

Theme	Number of comments relating to theme	
	Year 1	Year 2
Teaching Experience	43	38
L&T Approach	61	36
Assessment Task and/or Support	22	21
Learning Technologies	67	69
Specific Sessions / Topics	17	9

When identifying the themes based on student comments, the teaching experience received a number of positive comments. The level of positivity afforded to experience itself was not expected. However, on reflection this could be explained in part by structural functionalism, as discussed in section 4.8. How students viewed and valued the module; and the social capital generated between staff and students could have been influenced by their awareness of the study itself. Themes generated from feedback about learning technologies and L&T approach, however, should not be unexpected, especially as there were targeted questions about their use, encouraging students to reflect on those aspects specifically. The illustrative quotes that follow were taken from both year groups involved in the study:

Teaching Experience

Enthusiastic staff that make the learning interesting and therefore easier to learn.

Staff were very helpful and explained things clearly

Teaching was fantastic, and all sessions were enjoyable

L&T approach

Teaching was delivered in a variety of ways which made it more interesting

Different learning resources helped different learning styles

The variations in styles of teaching really improved my learning

Inclusive learning

The interactivity

Assessment

Mock practicals before the exam

Lots of support around assessment

The preparation time available for the assessments

Preparation for the exam was thorough and helpful

Lots of prep and information about the exam

Learning technologies

Good use of iPads and interactive resources made it more interesting and good for revision

The online resource (website) means that we could go back and revisit topics when we were unsure

Technology learning through online workbooks

Variety of teaching and media used e.g. Simman, 3D Suite, iPads

Using the Simman and using the 3D in lessons helped me with my learning as I am a visual learner.

5.5.1.2 Constructive module evaluation comments

The same process for analysis of student comments was undertaken for the free-text question *"Please identify up to three things you would like to see changed about the module (and why)"*. Statements were reviewed repeatedly, coded and themes were generated based on the type of comments observed. Enough themes were generated to ensure each item of feedback could be allocated to one of the themes. Several themes identified in the positive module evaluation comments were also identified within the constructive module evaluation comments; although not all themes were mirrored in both. The issue that generated the most constructive comments was Assessment. These were clustered around two key areas: assessment bunching with other tasks/modules and clarity of/support for the written assignment. Changes that were in the gift of the module team to change notwithstanding, many of these comments were in relation to the clustering of assessment with the other specialism modules and the presence of a written assignment; neither of which were within the gift of the module leader to change. As outlined in section 2.2.6 the cardiovascular-respiratory module was the only one of the three specialism modules to contain a written assignment. Whilst the rationale for this was clearly made to students, it is interesting that the presence of a written task was still viewed negatively by some students.

Another theme that appears to have received a significant amount of constructive feedback was the theme titled 'Specific Sessions / Topics'. This is an overarching theme about teaching subject clarification and session lengths. The module feedback received as part of the study indicated that several topics were no longer of concern for students; however, these had been replaced with other topics with which they felt less confident. The constant challenge within a given module is the balance between covering the indicative content in enough detail to enable students to best meet the Learning Objectives, whilst working within the organisational constraint of maximum tutor-directed (i.e. direct classroom) time. This is explored further following the presentation of the focus group themes and within section 7.2 when discussing the development of clinical reasoning skills.

Table 5.26 provides a summary indicating number of comments per theme followed by exemplar quotes. Despite changes made to assessment support following year one's feedback, this remained an area of concern with the greatest number of comments about necessary improvements.

Table 5. 26 Student feedback in relation to the module evaluation question: Please identify up to 3 things you would like to see changed about the module (and why)

Theme	**Number of comments relating to theme**	
	Year 1 **n=104**	**Year 2** **n=85**
Assessment task and/or support	34	39
Learning technologies	26	31
Specific sessions / topics	32	22
Practical / case studies	15	7

Assessment task and/or support

The written assignment was timed too close to practical exams of other modules

Respiratory assignment to be done after exams not during!

Timing of the respiratory assignment in relation to other assignments

More support for assignment as structure and content was not clear

Would like to see assessment tasks spaced out better. Not just this module's fault admittedly.

Learning technologies

Use of Simman earlier in the module as it is a good learning tool

iPad group interaction was hard at times due to limited iPads as one person mainly did work on one iPad in a group activity.

Use 3D first for anatomy

Use videos for interventions first before workbooks to understand them

There should be more opportunities for the use of the iPads to interactively fill in work sheets as the discussion and resource created by this activity were really helpful

Use of iPads and computers weren't as useful

Specific sessions / topics

More teaching on pathologies; more time to cover more detail for pathology and use of interventions

More practical sessions on oxygen therapy - mask use etc.

Possibly more focus on cardiovascular system. I felt very well prepared for respiratory conditions but not so much for CV.

Practical / case studies

More hands on; More Simman

More case studies to be discussed after lecture, so student knows how to interpret Ax findings with Rx plan

I would like there to be more practice case studies

From the feedback provided in the free-text sections of the module evaluation form it can be observed that there were more positive comments than suggestions for improvement. There was positive feedback about the variety of the L&T approaches employed and the teaching experience. The use of simulation, online resources, iPads and 3D resource also received much positive feedback; although it has been noted that there were also some negative items in relation to the use of the 3D suite and the use of iPads. All suggested improvements related to simulation, requesting earlier and increased utilisation.

5.5.1.3 Summary of Module Evaluation Comments

It is clear from the module evaluation that students felt overwhelmingly that the culmination of L&T resources and activities within the module improved their understanding as a whole, with 91% of respondents either mostly or definitely agreeing. This provides useful insight into the overarching learning experience, but it was not possible to identify whether students felt one approach was superior to another. The increased use of simulation and case studies indicates that students place importance on applied, scenario-based learning. Furthermore, students requested more teaching to help develop understanding of pathologies. Both these recommendations suggest a desire for more applied, clinically authentic learning opportunities. However, it is not possible to conclude from this study whether this would improve module marks or the development of clinical reasoning skills.

5.5.2 Focus Groups

As outlined in Chapter 4, focus group interviews were utilised to gain further understanding of the learning experiences throughout the module and to enable insight into the learning and teaching approaches that were perceived as being the most impactful. This understanding was necessary to answer the fourth research question and to provide narrative for use in conjunction with the quantitative data.

The process of thematic analysis (Denzin and Lincoln, 2008; Tashakkori and Teddlie, 2010; Burns and Grove, 2010) was adapted in light of the use of video analysis, but followed the process of identifying, clustering and refining of key topics into themes, as presented in section 4.9 of Chapter 4. Four emergent themes were identified as a result of the analysis process:

- Clinical Application
- Self-Assessment of Learning
- Learning Environments
- Learning and Teaching Approach

5.5.2.1 Clinical Application

Clinical application and transference of classroom-based learning to practice was a strong theme within two of the focus groups. Lack of 'actual' patients within the module was still seen by some as a significant challenge and potential barrier to learning. Many of the participants gave examples of what they had observed or experienced in clinical placement that had impacted most on their understanding and clinical reasoning. Some of these examples then influenced the interviewer's questions, probing participants as to how this could be replicated in a classroom environment. Participants outlined that whilst the use of simulated case studies to an extent facilitated clinical reasoning, the inability to replicate true patterns of work of breathing and respiratory distress, for example, meant that linking clinical signs and symptoms was limited.

There was a broad range of opinion as to what facilitated the greatest learning and transference to practice; however, the use of more varied case studies, and the desire for more visual resources, were raised repeatedly by all groups. Ultimately, whilst there was varied opinion as to how well or what resources supported transference of knowledge and understanding to practice, there was consensus about the importance of being able to do this. For participants, visualisation and practical experience were key as gateways to enabling transference to clinical practice; with the two main vehicles within the classroom environment being online video resources and the practical use of Simman with realistic augmented reality overlay. Despite exploring ways in which classroom experiences could better prepare and mimic the clinical environment, strong opinion remained as to the importance of actual clinical experience:

> *"As soon as you saw someone out of breath, it just made sense"*
>
> *"The more practical it is, the better, just sitting there watching a video isn't helpful"*
>
> "*Respiratory didn't click until I went on placement. You need it in front of you*"
>
> "*Respiratory is a very difficult thing to do unless you've done it in practice*"
>
> "*I found it so hard to even understand the basics bits. I'd never seen a* [respiratory] *patient*
>
> "*Using Simman ... makes you think a lot more rationally and realistically*"

This highlights the assumptions of some students that nothing can prepare them for actual practice. However, it may merely be that the L&T resources and activities were not sufficiently authentic to apply to clinical practice. It also poses the challenge in identifying how much simulated or authentic practice is enough for students to feel prepared for what is essentially, for some, the unknown. As discussed in Chapter 2, the development of clinical reasoning requires actual experience. Whilst simulation provides opportunities for active learning, it is impossible to fully replicate and hence prepare novice students for clinical placement.

5.5.2.2 Self-Assessment of Learning

The use of formative assessments as an important facilitator for learning and the identification of ongoing development needs was raised by all groups. Two of the groups linked this to the MCQs specifically, discussing the importance of, and suggested increase in using MCQs to support and guide learning. Participants offered comments on the value of assessment as a mechanism for learning, making links to being strategic in relation to prioritising their learning. Focus group participants appeared to have a strongly held belief that the MCQs and formative Simman activities acted as a barometer for their current level and where they needed to focus their efforts to improve.

> "*They made me realise how much I knew and how much to revise*"
>
> *"The Simman mock exam really helped me understand what was expected of me in the exam"*
>
> *As much as I hate assessment, early assessment makes you learn it.*"
>
> "*It cements what you've just gone through. Cements what you've learnt as you go along. Highlights what you need to know*"

The views expressed within the focus groups as to the value of formative assessment should be considered alongside the results presented in section 5.4. The assertion that they enabled accurate identification of strengths and ongoing learning was not substantiated. There was no relationship seen between student self-assessment of knowledge and clinical ability, and the scores awarded from the MCQs, or the module's summative assessment tasks. The relative value of MCQs, the approach to assessment for learning and the role of self-assessment are discussed in more detail within Chapter 7.

5.5.2.3 Learning and Teaching Approach:

Several discussions across each of the focus groups explored the impact of a variety of approaches, activities and/or resources, linked to interaction, engagement and the facilitation of learning. Many of the participants related specific examples from the module to how they learned. All participants demonstrated an awareness of different learning styles with the term 'visual learner' being used repeatedly within discussions. Evident during these discussions was the level of agreement about the need for a variety of resources and approaches. However, there was a lack of agreement as to what approaches, activities and resources would best suit particular topics:

> "*The 3D stuff. I really liked it; I could visualise what was happening*"
>
> *"The videos and workbooks together worked really well.*"
>
> "*Problem solving with the workbooks - it was really exciting*"
>
> [In relation to a Google docs activity] "*It was nice seeing what everyone else had done and being able to go back to it after class*"

Whilst there was much discussion about the need to visualise clinical presentation to create meaning and application to practice (discussed further in section 5.2.3), the use of 3D visual learning resources had mixed responses. Two participants did not find the 3D resources and some of the videos of benefit stating:

> "*I didn't find it* [3D] *that helpful*"
>
> "*I hated the 3D learning; I would have been much happier with a PowerPoint and a flat screen.*"
>
> "*I read the* [video] *transcripts. I preferred that to watching the videos.*"

In addition, two of the focus groups explored the different approaches to the pathologies workbook: traditional vs media-rich. There was general agreement that the online video-based pathology workbook was less daunting and structured in a way that was less over-facing, enabling students to select which aspects they wanted to explore rather than feeling obliged to complete the workbook in its entirety. Some participants identified the traditional workbook as being too over-facing whereas others really liked it as a framework to guide what they needed to study.

"It was too big, too daunting"

"I really liked it; I just went through it systematically"

Notable during focus group discussions was the way in which students appeared to interchange the term 'learning' with 'engagement'. There appeared to be an assumption that the variety of resources and interactive nature of teaching sessions increased student engagement which in turn resulted in improvements in learning:

"*Stuff can be so boringly delivered* [in other modules] *but in respiratory I don't think I've ever sat there thinking, or come out thinking I don't know anything*"

"*Constantly active; either doing an activity or moving on. You've got to pay attention. Other modules are more sedentary.*"

"I just felt the respiratory module was completely, completely different. If you look at it in terms of colours, respiratory was like red and blue and yellow and green and pink and with daisies. When you look at xxxx and xxxxx [other modules] *it was black and grey and rain"*

"Our group was completely different in respiratory; the way we would engage within sessions, discuss. Everyone contributed"

The assumptions made by the focus group participants that engagement facilitates learning cannot be fully substantiated by the quantitative data as there was no significant improvement in overall module mark when compared to previous cohort assessment mark outcomes. The implications of these findings are discussed within section 7.2.

It was interesting to note how participants in one group described adapting the resources provided by the module team to best align to their preferred approach to learning. This involved re-formatting some resources, adapting some in advance of a session to enable better note-taking, and engaging in specifically designed resources in a way that was not expected (i.e. minimising a video on the screen to remove the visual element, and just listening to the audio). Whilst there were some requests for a small number of topics to have a variety of resources to aid different learning styles, generally participants were keen to discuss how to improve or redesign the available resources on a given topic. The inference made by the researcher was that the participants of that focus group had an awareness of the most effective approach to optimise their own learning, coupled, possibly, with an understanding that requesting multiple resources and formats for a specific topic was not reasonable or feasible. Therefore, in the absence of specifically tailored resources, students became resourceful in utilising what resources were provided within the module, altering them or using them in conjunction with other resources that optimised their learning.

5.5.2.4 Learning Environments

Wider factors impacting on learning were raised by two of the three focus groups. This ranged from needing smaller group sizes, type of room and accessing equipment. Some learning spaces were evidently not always conducive for the activities undertaken, for example using the 3D suite for teaching beyond that of experiencing the virtual reality. Smaller group size and the impact on a student's confidence to ask questions were discussed in detail by one group, but the issue of group size was commented on by all groups. As can be seen from Table 5.1, year one cohort consisted of more than 100 students. With only three teaching groups that meant an average staff to student ratio per teaching session of 1:33. This included some, but not all, practical sessions. In a small number of simulated sessions there were three staff present due to the nature of the simulated and 3D activities. This staff to student ratio of 1:11, whilst arguably delivering a more positive, personalised learning experience, is not sustainable or financially viable long-term.

> *"I think it's important to get in some smaller classes and more individualised learning"*
>
> *"In terms of the 3D learning suite. I think it's really good to use but we just need smaller classes / groups"*
>
> *"Sometimes there were not enough seats or headsets for everyone"*

The impact of the learning environment was also discussed in relation to distractions and digressions away from the learning activities themselves. In addition, student behaviours were also raised as a potential distraction, perhaps indicating that establishing ground rules were necessary. This raises an interesting point in relation to behaviourism and conditioned responses, as discussed in section 2.2.3.1. The introduction of iPads within the session appeared to bring about changes in how some students behaved, consideration of which is discussed in section 7.3.3.

> *"When we were using the iPads and those video resources, we were all doing it at the same time and it was hard to hear at times"*

"*iPads are such a good idea when used properly.... but when you have people not using them correctly and you're sharing them between 4 of you... if they're mucking about with it....*"

"*The more people get familiar with them* [iPads] *the easier it will become to use them*"

"*.. making it work; not allowing the technology to detract from the activity.*"

"*The 3D suite gave me a headache*"

"*It was such a dark room* [3D suite] *and I needed to make notes*"

In addition to the physical environment, students commented on the accessibility of the resources utilised in class away from the classroom. Suggestions on how to improve accessibility by one group included making the 3D video resources 2D but available to view online outside of formal teaching. In addition, there was an awareness that many of the 3D resources were purely visual but supplemented in class by discussion and explanation from the tutor. Suggestions to improve accessibility and understanding included narration/commentary and/or annotation. These discussions caused the researcher to consider how the students accessed learning resources from the module beyond the classroom; and whilst it appeared that participants were happy to source additional resources, there was a real desire to revisit the learning they received within the classroom.

5.5.2.5 Summary of Focus Group Findings

Whilst the visual and practical elements of the module redesign provided a largely positive response from the focus groups, students still voiced concerns that they were not able to fully envisage clinical presentation, and they felt more could be done to better prepare them for practice. The value students placed on the role of simulation was apparent within the module evaluation but did not dominate conversations within focus group discussions; however, authenticity and realism of learning did feature. The ability of learning resources to offer authentic scenarios that enable students to visualise and transfer their learning to clinical practice still seems to prove challenging. Students still report feeling unsure in their understanding of how pathologies manifest and present clinically. This will likely impact on the development of their clinical reasoning. The utilisation of the various resources and approaches within this study, and the impact they have had on both quantitative data and qualitative findings will be discussed in section 7.2.

Self-assessment of learning and the role of formative assessment was an unexpected theme that emerged from discussions. Students placed significant value on the range of formative activities in preparing themselves for the module assessment and/or clinical practice. This is despite there being no demonstrable relationship between the quantitative measures and students' self-assessment scores. It is the perceived value of self-assessment coupled with the student perspective on the clinical application of learning and teaching resources theme that warrants further discussion and investigation. Authenticity of learning resources and assessment activities to develop clinical reasoning, coupled with the role of self-assessment are explored in more detail within Chapter 7.

The novel approach taken to the analysis of the focus groups enabled meaningful insights to be drawn as well as observation of behaviours, non-verbal communication, and the body language of the researcher. Through a combined approach of transcription and observation, the identification of themes emerged that supported the sequential exploratory design and provided rich data and insights. This approach supported the researcher in being confident that no new data were emerging, and that data saturation had been reached. This is discussed further in Chapter 7

5.6 Summary of Results

This study set out to investigate the impact of redesigning the CVR component of an undergraduate physiotherapy curriculum on students learning outcomes, self-assessment of clinical ability and their learning experience. Few studies prior to this had explored learning outcomes and experience concurrently. Fundamental to the study's aims was whether the curriculum changes better facilitated students' clinical reasoning in the field of CVR and provided a positive learning experience.

It is clear from the range of data presented in this chapter there was an improvement in module attainment, narrowing the gap between the CVR module and the other L5 specialist modules running concurrently. However, no significant improvement in overall module mark was seen in either cohort. The implication here is that whilst the improvements were statistically significant when compared to the MSK specialism module, they were not of educational significance in that they did not facilitate a significant upward shift in marks sufficient to elevate a middle-band student to the next band.

The self-assessment scores of students showed a significant improvement after the initial teaching intervention, with further improvements seen after crossover. However, there was no relation between the self-assessed scores and either the MCQ scores or the mark awarded by module tutors for the simulated assessment task. The implications of apparent discontinuities between formative, summative and self-assessed scores will be considered within Chapter 7.

Students reported that they value a variety of approaches within L&T, indicating this improved engagement. The assumption that increased engagement equates to improved learning outcome was also expressed, despite the lack of quantitative findings to substantiate this. The perception that the engagement generated by the use of interactive L&T approaches and video-based resources equates to improved learning will be discussed in Chapter 7.

Worthy of note is the duration of the study. Advancements in technology and the educational research base in relation to this has progressed dramatically. Therefore prior to discussing the results in Chapter 7, Chapter 6 provides a synopsis of literature that has emerged since the study's commencement and aligns to Chapter 3's key areas of learning technology focus: Simulation; and Blended Learning, specifically the use of video-based resources.

CHAPTER SIX: BRIDGING LITERATURE REVIEW

Running parallel to this study have been significant changes within both the healthcare and learning technologies landscapes. This chapter sets out pertinent literature that has emerged since this study commenced. The proliferation of Learning Technologies utilised within Higher Education has led to a greater knowledge-base than was available at the out-set of the study. The aim of this chapter is not to revisit the full literature review presented in Chapter 3. Instead, the aim of this bridging literature review is to situate relevant current research to enable the discussion chapter (Chapter 7) to draw on current thinking in relation to the study's findings. This chapter will therefore focus on the types of Learning Technologies that were utilised within this study: simulation; and video-supported learning. The body of research on video-supported learning is thought to be of relevance; and sits within the wider Blended Learning evidence base.

6.1 Simulation

A repeat literature search was undertaken using the same search terms used at the outset of the study (Table 6.1). The process of refinement and selection is outlined in Table 6.2. This literature review focuses on systematic reviews and meta- analyses of simulation-based Physiotherapy education and those primary studies investigating the impact of simulation on CVR Physiotherapy knowledge and skills. A summary of the papers reviewed is provided in Table 6.3

Table 6. 1 Search strategy for the identification of current simulation literature

Databases searched	ProQuest Central MEDLINE/PubMed ProQuest Education Journals Science Direct
Search terms	Subject: Simulation/Simulations/Simulated Learning* AND Healthcare Education OR Physiotherapy/Physical Therapy* Education
Limits	Language: English Publication date: 2013-2019 Type: articles; peer-reviewed journals
Inclusion criteria	Undergraduate Available online Higher Education setting Physiotherapy* Education Cardiovascular-respiratory specialism Experimental, quasi-experimental, systematic review
Exclusion criteria	Behaviours (e.g. risk taking, communication) Specific skill acquisition / non-cardiovascular-respiratory specialism (e.g. venopuncture, neonates obstetrics) Interprofessional education Computer-based Historical summary Non-systematic review

Table 6. 2 Refinement process to enable identification of pertinent simulation literature

Number articles generated	338
Number after duplicates removed	321
Number after exclusion criteria applied to Title	62
Number after exclusion criteria applied to Abstract	32
Number after exclusion criteria applied to Full Text	6

Table 6. 3 Summary of Simulation papers reviewed

Study	**Design**	**Participants**	**Analysis**	**Findings**
Type of study: Systematic Review		**Studies reviewed**	**Process of analysis**	
Macauley K, Brudvig TJ, Kadakia M, Bonneville M, (2017) *Systematic Review of Assessments That Evaluate Clinical Decision Making, Clinical Reasoning, and Critical Thinking Changes After Simulation Participation*	SR	31 27/31 qualitative 3/31 quantitative 1/31 MM	PRISMA guidelines followed MMAT Tool used for analysis 2 reviewers; 3rd reviewer for discrepancies	Supports the role of simulation beyond psychomotor skills. Greater evidence that it supports the development of clinical decision-making, clinical reasoning and critical thinking No aggregate findings due to heterogeneity of papers reviewed
Mori B, Carnahan H, Herold J, (2015) *Use of Simulation Learning Experiences in Physical Therapy Entry-to-Practice Curricula: A Systematic Review*	SR	23 (4 clusters) 1: Sim for specific skills (8/23) 2: Programmed sim (3/23) 3: Sim Case scenarios (5/23) 4: As a representation of clinical practice (7/23)	MERSQI instrument used for analysis 2 reviewers	Cluster 1: mainly MSK papers. No LT improvements in skill Cluster 2: effected a change in perspective on ageing Cluster 3: mainly CVR papers. Clear safety advantages. Cost-benefit analysis needed. Cluster 4: large range of outcomes. Improved self-assessment No aggregate findings due to range of quality of studies reviewed

Type of study: Systematic Review	**Design**	**Studies reviewed**	**Process of analysis**	**Findings**
Pritchard, SA. Blackstock FC, Nestel D, Keating JL(2016) *Simulated Patients in Physical Therapy Education: Systematic Review and Meta-Analysis*	Systematic Review and Meta-Analysis	14 studies (7/14: single-case reports (3/14 RCTs) (1/14 non-RCT) (3/14 Qual)	PEDro Scale (Quant) and QAQRR Scale (Qual) used for analysis 2 reviewers	Simulation vs Clinical placement: no significant difference found Simulation vs role play: no significant difference in self-assessment or satisfaction Simulation vs no simulation: no conclusions drawn due to poor quality findings,
Type of study: Quantitative	**Design**	**Participants**	**Measures**	**Findings**
Phillips AC, Mackintosh SF, Bell A, Johnston KN (2017) *Developing physiotherapy student safety skills in readiness for clinical placement using standardised patients compared with peer-role play: a pilot non-randomised controlled trial*	Non-randomised controlled trial	108 year 2 students Survey response rate: 85%	Adapted survey and OSCE mark	CVR (Intensive Care Mobilisation) teaching focus of the study to reduce the number of students failing on placement for safety reasons Both approaches effective in increasing confidence and reported preparedness for clinical placements: higher levels of satisfaction in simulation group. Simulation may be more effective than role play, but not statistically significant
Type of study: Qualitative	**Design**	**Participants**	**Process of analysis**	**Findings**
Melling M, Duranai M, Pellow B, Lam, B, Kim Y, Beavers L, Miller E, Switzer-McIntyre S,(2018) *Simulation Experiences in Canadian Physiotherapy Programmes: A Description of Current Practices*	Semi-structured interviews	8 Physio educators	Thematic analysis (5 investigators)	Three main themes identified: 1 variability in the definition of fidelity in simulation – consistent with literature 2 variability in simulation use, and 3 the benefits of and barriers to the use of simulation. Conclusions: Physiotherapy programmes are using a variety of simulations, with the aim of creating a bridge from theoretical knowledge to clinical practice Used predominantly for CVR Physio education

Type of study: Mixed methods	Design	Studies reviewed	Process of analysis	Findings
Silberman NJ, Litwin B, Panzarella KJ, Fernandez-Fernandez, A (2016) *High Fidelity Human Simulation Improves Physical Therapist Student Self-Efficacy for Acute Care Clinical Practice*	Randomised exploratory study	16	Focus Groups – topics identified Self-efficacy questionnaire	Safe, non-judgmental environment Facilitated communication Fostered clinical reasoning skills Facilitated multi-tasking/complex skills

Of the papers reviewed, three were systematic reviews (Macauley, Brudvig, Kadakia, and Bonneville, 2017; Mori, Carnahan, Herold, 2015; Pritchard, Blackstock, Nestel and Keating 2016), one was a non-randomised trial (Phillips, Mackintosh, Bell, and Johnston, 2017), one was a qualitative study (Melling, Duranai, Pello, Lam, Kim, Beavers, Miller, Switzer-McIntyre, 2018) and one was a mixed methods study (Silberman, Litwin, Panzarella and Fernandez-Fernandez, 2016). All Systematic Reviews were able to identify claimed benefits of simulation for the development of clinical reasoning and preparation/transference of learning to practice, moving beyond the early literature focusing purely on psychomotor skills. However, they also identified that whilst there can be some overarching assertions made, it was not possible to draw robust conclusions due to the heterogeneity of studies and the range in methodological quality. Pritchard, Blackstock, Nestel and Keating (2016) analysed studies comparing simulation to either clinical placement or role play. Again, they were able to report commonality of findings, in the role of simulation in having a positive impact on learning, but again, identified a lack of methodological rigour to enable robust conclusions as to its efficacy over and above other methods of learning.

Melling, Duranai, Pellow, Lam, Kim, Beavers, Miller and Switzer-McIntyre (2018) interviewed academics delivering simulation as part of UG Physiotherapy education programmes. This qualitative study identified that a variability in the definition and utilisation of simulation still exists, with different approaches to debrief articulated by participants. Their study supports claims about the benefits of simulation, particularly within the field of CVR Physiotherapy as a means to create a bridge from theoretical knowledge to clinical practice. However, the authors reported that there is still a lack of evidence that simulation aids the development of self-reflection. This is in contrast to the conclusions drawn by the aforementioned Systematic Reviews and indeed the findings of Silberman, Litwin, Panzarella and Fernandez-Fernandez (2016) who undertook a mixed methods study evaluating the use of high-fidelity human simulation for UG Physiotherapy students studying acute respiratory care. Silberman et al, (2016) concluded that simulation better prepares students for acute care and leads to increased self-efficacy. Whilst this was only a small study, the use of a validated Acute Care Confidence Survey provides a firm basis on which they drew their conclusions.

Phillips, Mackintosh, Bell and Johnston, (2017) undertook a large non-randomised study comparing the outcome of role play vs simulation in improving the safety of students undertaking an observed standardised clinical examination (OSCE). The methodology utilised aligns most closely to this study as it compared marks awarded by experienced clinical staff with perceptions of students. It identified simulation as being a preferable learning experience than role play and was more effective. However, this latter assertion was not a statistically significant finding.

It is clear that there has been a proliferation of studies about the use of simulation in UG Physiotherapy education over the last 5 years; and many of those studies indicate that simulation is effective in developing clinical reasoning. However, it is still challenging to draw robust conclusions or identify the most impactful way to integrate it into undergraduate physiotherapy education programmes due to the variety of ways in which simulation is being defined, delivered and researched. There are also now more studies investigating the impact on self-efficacy, although the lack of consistency in terminology and approach, and the varied use of debrief means there is still a lack of robust evidence to inform best practice.

6.2 Video-Supported Learning

The literature surrounding video-supported learning in healthcare education has increased considerably in the last 5 years. As outlined in Chapter 2, students requesting to visualise areas of theoretical content or clinical presentation was a key driver in developing the video-based and online resources used within this study. At the outset of the study, limited literature was available on the use of video-supported learning in healthcare education; and what was available could be located within the umbrella of Blended Learning. However, in the following years, there has developed a stronger evidence-base for video-supported learning in healthcare education and hence it was deemed appropriate to undertake a critical review of the available literature in this area in light of the resources used within the study, and to provide greater context for discussion in Chapter 7. A search of the literature to identify the existing evidence-base for the use of instructional videos was therefore undertaken. Tables 6.4 and 6.5 outline the search strategy and the refinement process for retrieving the relevant studies. Table 6.6 summarises the papers reviewed.

Table 6. 4 Search strategy for the identification of possible relevant blended learning literature

Databases searched	ProQuest Central MEDLINE/PubMed ProQuest Education Journals Science Direct
Search terms	Subject: Video Learning OR Educational Video AND Higher Education
Limits	Language: English Publication date: 2006-2019 Type: articles; peer-reviewed journals
Inclusion criteria	Undergraduate Available online Higher Education setting Physiotherapy* Education Nursing* Education Medical * Education Science* Education Augmented Reality Virtual Reality Experimental, quasi-experimental, systematic review, case example
Exclusion criteria	Teleconferencing Telehealth Interprofessional education Gaming Simulation Patient education

Table 6. 5 Refinement process to enable identification of pertinent Video-based literature

Number of articles generated	329
Duplicates removed	18
Number after exclusion criteria applied to title	64
Number after exclusion criteria applied to abstract	21
Number after exclusion criteria applied to full text	13

Table 6. 6 Summary of papers investigating the use of video

Study	Design	Participants	Analysis	Findings and strength of findings relative to methodology (finding from + to + + +)
Type of study: Quantitative				
Mohammadzadeh Akhlaghi, N., Khalilak, Z., Vatanpour, M., Moshari, A., Ghaffari, S., & Namazikhah, M. S. (2017). *Students' knowledge comprehension after implementation of live conventional demonstration, video teaching and video-assisted instruction methods in endodontic practice*	Randomised trial	N=42 14: demonstration 14: video 14: video plus commentary	MCQ ANOVA and multi-comparison	Strength of findings: ++ Video plus live commentary most effective No difference between live demonstration alone and video alone
Alqahtani, N. D., Al-Jewair, T., Al-Moammar, K., Albarakati, S. F., & ALkofide, E. A. (2015). *Live demonstration versus procedural video: A comparison of two methods for teaching an orthodontic laboratory procedure.*	Randomised trial	N= 49 Grp A: 26 Grp B:23	OSCE Score	Strength of findings: + No significant difference in procedural ability Students report a preference for live demonstrations from tutors
Bonacaro, A., Williams, G., & Brownie, S. (2014). *Teaching basic life support to the digital generation: Randomized trial comparing video assisted versus practical simulation.*	Randomised trial	N=127 Low-fid simulation: 64 Med-fid simulation: 63	Pre-test: post-test	Strength of findings: ++ Equally effective in terms of student outcomes, but low-fid sim much more cost-effective Knowledge retained at 4 months

Study	Design	Participants	Analysis	Findings and strength of findings relative to methodology (finding from + to + + +)
Type of study: Quantitative				
Castillo, J., Gallart, A., Rodríguez, E., Castillo, J., & Gomar, C. (2018). *Basic life support and external defibrillation competences after instruction and at 6 months comparing face-to-face and blended training. randomised trial.*	RCT	N=129 Traditional f2f Self-training video + VLE + 45min f2f	MCQ OSCE	Strength of findings: +++ Equally effective in terms of student outcomes Knowledge retained at 6 months was higher in the video and online training group
Devi, E. S., Mayya, S. S., Bairy, K., George, A., & Mohan, M. K. (2013). *Comparative analysis of the outcome of two teaching learning approaches adopted for teaching pharmacology.*	Quasi-experimental Crossover	N=167 Control: 80 (live demonstration) Experimental: 87 (video)	Knowledge Questionnaire Student experience questionnaire	Strength of findings: ++ Significantly better scores seen in Video group Students identified variety of L&T approach preferable, not one method
Tarpada, S. P., Hsueh, W. D., Newman, S. B., & Gibber, M. J. (2017). *Formation and assessment of a novel surgical video atlas for thyroidectomy.*	Quasi-experimental Randomised Pre-test post-test	N=37 Control: 19 (textbook) Experimental: 19 (video)	Short answer questions and experience questionnaire	Strength of findings: + Significant increase in scores with the video group compared to the control group Greater student satisfaction with the video group: perceived better-quality learning

Study	Design	Participants	Measure/ Analysis	Findings and strength of findings relative to methodology (finding from - - - to + +)
Type of study: Quantitative				
Thilakumara, I. P., Jayasinghe, R. M., Rasnayaka, S. K., Jayasinghe, V. P., & Abeysundara, S. (2018). *Effectiveness of procedural video versus live demonstrations in teaching laboratory techniques to dental students.*	Quasi-experimental Pre-test post-test	N= 36 Live demo=40 Video=36	Knowledge Skills Perceptions	Strength of findings: ++ Both effective in improving knowledge and skills – no significant difference between the 2. Students preferred video resources
Wakode, S. L., & Wakode, N. S. (2018). *Enhancement of student centered learning using video based practical demonstration in first year medical undergraduates*	Quasi-experimental	N=100 Control: 50 (live demo) Experimental: 50 (video)	OSCE Student perceptions questionnaire	Strength of findings: ++ Video more effective than live demonstration in developing practical skill. Students preferred video resources
Sarıhan, A., Oray, N. C., Güllüpınar, B., Yanturali, S., Atilla, R., & Musal, B. (2016). *The comparison of the efficiency of traditional lectures to video-supported lectures within the training of the emergency medicine residents*	Quasi-experimental	N=30 Control: traditional lecture Experimental: video	MCQs OSCE	Strength of findings: + No difference in MCQ scores But significantly improved OSCE scores in video group
Spofford, C. M., Bayman, E. O., Szeluga, D. J., & From, R. P. (2012). *Anesthesia machine checkout and room setup: A randomized, single-blind, comparison of two teaching modalities.*	Randomised Quasi-experimental Pre-test post-test	N=78 Control: 36 (traditional lecture) Experimental: 42 (video)	Written exam Satisfaction survey	Strength of findings: + Greater improvements observed among students in video-based teaching group, Students rated traditional, live lectures higher than video-based teaching

Study	Design	Participants	Measure/ Analysis	Findings and strength of findings relative to methodology (finding from - - - to + +)
Type of study: Quantitative				
O'Donovan, J., Ahn, R., Nelson, B. D., Kagan, C., & Burke, T. F. (2016). *Using low-cost android tablets and instructional videos to teach clinical skills to medical students in Kenya: A prospective study*	Feasibility study Pre-test post-test	N=51 Control: 26 (no teaching) Experimental: 25 (table with pre-loaded video)	OSCE	Strength of findings: + Improves clinical education and efficacy Cost-effective
Aldera, A. S. (2015). *Investigating multimedia strategies to aid L2 listening comprehension in EFL environment.*	Quasi-experimental	N= Control: 26 (audio) Experimental: 60 (video plus text)	Initial and medium-term follow-up listening comprehension test Student perception survey	Improved listening comprehension test scores in the video group with better retention in the video group at one-month follow-up

Mohammadzadeh Akhlaghi et al., (2017) investigated the use of video in dental practice education, finding that students who had access to video instruction displayed no significant difference in mean MCQ scores when compared to a conventional demonstration. They did, however, show that video with professional narration was favourable to no narration for trainee dentists to acquire knowledge regarding a procedure. When considering the premise of social cognitive theory, as discussed in section 2.2.3.3, this finding is perhaps not surprising. Alqahtani, Al-Jewair, Khalid, Albarakati, & ALkofide, (2015) undertook a similar study in dentistry education investigating clinical skill acquisition and student perceptions. This study compared a procedural video to a live demonstration. Results showed no statistically significant differences between groups. Despite this, most students indicated a preference for live demonstration, as this provides opportunities to ask questions.

Bonacaro, Williams, & Brownie, (2014) compared simulation to video-supported learning for basic life support (BLS) training with undergraduate nurses. Findings indicated that video assisted simulation was as effective as high-fidelity practical simulation when post intervention test scores were compared. However, video intervention was less resource intensive. These findings were supported by (Castillo, Gallart, Rodríguez, Castillo, & Gomar, 2018) who demonstrated no significant difference in MCQ scores between face to face training of BLS compared to video-supported learning materials and a short simulated activity. They did, however, find that MCQs scores dropped more at 6-month follow-up in the face to face training group than in the video-supported learning group.

Devi, Mayya, Bairy, George, & Mohan, (2013) compared traditional lectures to video and found statistically significant findings for knowledge gain in the video instructed groups, with some acknowledgement that this may be due to the learner's ability to revisit the material. Tarpada, Hsueh, Newman, & Gibber, (2017) identified 'video atlases' as being superior for gaining anatomy knowledge than traditional textbook resources in medical students. Video captured demonstrations were also identified as better than live demonstrations, when measured by procedural knowledge on pre and post-tests (Thilakumara, Jayasinghe, Rasnayaka, Jayasinghe, & Abeysundara, 2018; Wakode & Wakode, 2018). Whilst these studies tend to have small sample sizes and lack detail as to the standardisation of process for assessing practical skill, these studies do provide useful insights into the impact of video-based resources on student learning.

This finding was supported by Sarıhan et al., (2016) who also assessed the impact of video instruction in emergency care. Furthermore, performance improvements were found when teaching students surgical room setup using video-based resources compared to a traditional lecture (Spofford, Bayman, Szeluga, & From, 2012), However, this improvement was not maintained at follow up. These trials did not, however, look to control revision strategies, making comparisons of relative impact of the different approaches difficult. Positive results were reported in medical students using videos on digital tablets for 3 weeks prior to being assessed on their clinical skills (O'Donovan, Ahn, Nelson, Kagan, & Burke, 2016). However, it is important to note, that this study did not provide training in an alternate format to video, limiting conclusions of this study that video instruction is effective as a supplement to traditional teaching methods.

The use of video has been investigated in the development of language skills. Aldera (2015) found video animation to be preferable to audio resources alone for learning language skills, possibly indicating the value of observation in addition to audio processing. Whilst this is not directly transferrable to healthcare education, observing behaviours and body language is an important part of effective communication (Gluyas, 2015).

6.3 Summary

More recent literature supports the assertion that simulation is effective for the development of clinical reasoning and preparation/transference of learning to practice. However, despite the proliferation of literature, robust conclusions are still limited due to the heterogeneity of research. Furthermore, it can be seen that good quality evidence now exists for the use of video, not only as a supplement to traditional teaching methods, but as an integral component of the learning process in its own right. Further research is required, however, to enable direct comparison of video-based resources and tradition teaching methods on student learning, beyond that of MCQs.

Currently, the available literature indicates stronger evidence for video supporting the development of psychomotor skills, although improvements in knowledge acquisition has also been shown. The recent quality evidence underpinning the inclusion of video in facilitating students to acquire a host of skills is very positive, with many studies across a range of disciplines concluding that video use can improve the ability of students to acquire and reproduce a skill. Less clear, and under-investigated to date, is how video resources can support the development of non-physical skills such as professional communication or clinical reasoning skills.

CHAPTER SEVEN: DISCUSSION

This study has shown that: the module redesign and the inclusion of range of learning technologies led to improvements in student knowledge, understanding and clinical reasoning, when compared to the other specialism modules; self-assessment scores did not show any relationship with assessed measures, suggesting the need for greater use of facilitated debrief and reflection on and in-action; the redesign and the inclusion of learning technologies impacted positively on the student experience, with variety being identified as an important factor; and visual resources and simulation were seen by students as having the greatest potential to aid application of learning to clinical practice.

In order to highlight the study's main contributions to knowledge, the findings are reviewed in relation to the core themes that have spanned the thesis: the development of knowledge and understanding (section 7.1); the development of clinical reasoning, including self-assessment (section 7.2); and the learning experience (section 7.3). A reflection on the use of video analysis of focus groups is provided in section 7.4. Consideration is then given to the limitations of the study (section 7.5), before the final conclusions (section 7.6) and recommendations (section 7.7).

7.1 Knowledge and Understanding

Prior to the redesign of the module, the Level 5 CVR module was perceived to be more challenging to students than the two other specialism modules (MSK and Neuro); with a statistically significant lower average module mark for CVR than those marks seen in the MSK and Neuro modules. In order to be confident that the increase in CVR module mark was due to the interventions trialled within the study, and not purely a cohort effect (Keyes et al., 2010), the module marks were compared to the other two specialism modules that ran concurrently. The statistically significant improvement in CVR marks not being mirrored within the 2 other specialism modules, and indeed a narrowing of gap between those modules and the CVR module, provides a level of confidence that the observed increase in module marks was a direct result of the learning and teaching approaches utilised within the study. This demonstrates that the redesigned module was effective in improving the CVR Physiotherapy knowledge and understanding of students.

Whilst these results indicate that the module impacted positively on student attainment, it is important to consider how being part of the study itself may have had on student study behaviours. The Hawthorne effect has been described as an increase in productivity/effort as a result of being observed (McCambridge et al., 2011; 2014), with strong evidence in clinical trials that the process of being studied alone can be sufficient in bringing about a behaviour change (Sedgwick & Greenwood, 2015). Whilst this effect has been well documented since the early 20th Century, our understanding of it has been brought into question (McCambridge et al., 2011; Sedgwick & Greenwood, 2015). It is acknowledged that student involvement in the study could contribute to behaviour change, however, it could also be argued that a newly redesigned module co-created by students would promote increased engagement irrespective of any research. Arguably, students may have acted 'in solidarity' with their peers whom they knew to have re-designed the module, engaging more actively in the CVR module rather than the other specialisms; akin to structural functionalism behaviours outlined in section 4.8 (Burnham, 2018). The impact of the redesigned module on student engagement is discussed further in section 7.3: the learning and teaching experience.

The impact of the specific L&T approaches (traditional vs learning technologies) on knowledge and understanding, however, was more challenging to evaluate. It was demonstrated that both approaches were effective in improving knowledge and understanding; and cumulatively, due to the crossover nature of the study design, they brought about increased learning. The lack of differentiation between the traditional and the learning technologies interventions could be due to the lack of sensitivity or specificity of the measures used at each stage, or indeed the methodological decision to conduct a crossover design. Furthermore, the increase in engagement reported by the focus groups, attributed to the variety of approach and resources, may have brought about a change in study behaviours. This was not something that was explored within the scope of this study, and therefore it is not possible to determine whether the reported increase in engagement led to a willingness to undertake further self-directed study. These issues will be explored within section 7.5.

The lack of significant additional learning following crossover teaching delivery, demonstrable by the repeat MCQ scores, is of interest as it shows limited additional gain following the revisiting of topics. The crossover element of the study, and specifically the decision to revisit specific topics, was influenced by the students involved in the redesign of the module and was linked to those topics identified as Threshold Concepts outlined in section 2.3.2. These findings bring into question whether revisiting these specific topics in a similar way to how they were taught on the initial L&T intervention, afforded the best opportunity to optimise learning and to demonstrate attainment. When considering the integrative and bounded nature (Meyer & Land, 2003) of pathophysiological changes and clinical presentation, for example, revisiting them in a similar manner is perhaps unlikely to improve understanding. However, it is the lack of additional learning seen following the inclusion of visual and video-based resources after crossover that provides greater understanding of their potential to unlock barriers to understanding. This presents as an interesting juxtaposition when viewed in conjunction with the students' perspective of the value of visual resources.

7.2 Clinical Reasoning

The development of clinical reasoning and skills in CVR assessment, problem identification, goal setting and treatment justification of clinical case studies was the primary purpose of the module in which this study is situated. As discussed in Chapter 2 there are eight strategies that have been identified as supporting the process of clinical reasoning. These are diagnostic, narrative, procedural, interactive, collaborative, teaching, predictive and ethical (Higgs, Richardson and Dahlgren, 2004). The CVR module focused predominantly on the more acute cardiovascular-respiratory pathologies, their clinical presentation, and their management. This was due, in part, to how the curriculum was designed with rehabilitation and promoting long-term wellbeing situated within other modules. However, on reflection, it was also due to the CVR module being representative of more historic Physiotherapy practice and models of working, as outlined in section 1.1.5, focusing more on a medical model of hypothetico-deductive reasoning and diagnosis. This approach situated the module's approach to clinical reasoning predominantly within the structure and function and activity limitation domains of the ICF, thereby limiting the more participatory, patient-centred, narrative approach applicable to the ongoing management of long-term conditions.

Concurrent with this study has been a change in health and social care needs within society and an evolution in CVR Physiotherapy practice both in terms of how and where

CVR Physiotherapists work, as outlined in Chapter 1. The approach taken to clinical reasoning within the CVR module at the time may therefore not have been truly representative of the practice that students were experiencing on placement, particularly within the primary care setting. This may go some way to explain the discourse between the module marks that demonstrated students were able to clinically reason in line with the module assessment task's requirements, and the themes that emerged from the focus groups indicating students still felt teaching did not at times facilitate application of classroom learning into practice. The remainder of this section will consider these points in relation to the research findings about application of L&T resources and approaches and the self-assessment of clinical ability.

7.2.1 Application of Learning to Practice

Visual and video-based resources, increased use of case studies and simulation were identified by students as important features in bridging the gap between theory and the development of clinical reasoning skills. Whilst most focus group participants were clear that nothing could replace 'actual' clinical experience, they all identified how the L&T could better prepare and enable them for clinical practice. The importance of the range of visual and video-based resources attributed by the focus group participants and the perceived impact on learning, however, was not substantiated by the quantitative findings. Focus group participants indicated a perceived benefit of the video resources and they considered that these best enabled learning and application to clinical practice. However, despite the perceived benefit of video-based resources in transferring learning to a clinical context, they did not influence the students' perceptions of their own clinical abilities. The results from this study provide new insights into the types of video that are likely to influence a students' assessment of their own abilities and will be discussed in more detail in the subsequent section.

Participants identified the need to be able to visualise clinical presentation associated with cardiorespiratory pathologies for two purposes: to immerse themselves in simulation in order to comprehend the full cardiorespiratory objective assessment and problem identification process; and to know what to expect when encountering a patient on placement. These requests for more video/media-rich resources as well as increased use of case studies and simulation appeared to be the bridge between taught content and clinical practice in the students' eyes. The rationale given by focus group participants for requesting additional case studies was that variety and increased exposure would help them gain better understanding of the differing clinical presentations associated with the various pathologies. This highlights the ongoing challenge in facilitating application of concrete learning to different contexts. When considering the changing nature of healthcare and indeed CVR Physiotherapy services (sections 1.1.2, 1.1.3 and 1.1.5), this issue assumes greater importance. Due to the reduced likelihood of a CVR-specific placements, as discussed in section 1.1.5, it will be increasingly more difficult to provide students with the 'concrete' experience on which they wish to draw and apply to other contexts.

Irrespective of the underpinning motive requests for additional case studies, and in particular, simulated scenarios, this highlights that students did not feel able to transfer their learning beyond the case studies that they had directly experienced. Whether additional case studies would enable greater assimilation and breadth of knowledge to aid clinical reasoning, or just reduce the chance that students would experience a wholly unseen case study in the module's assessment or on placement, remains to be seen. However, the request for more case studies raised an interesting point about whether the module was effective in facilitating the application of learning into clinical practice; and if not, what factors could be contributing to this lack of transference.

As discussed within Chapter 3, key to the enablement of learning within a simulated environment is facilitated debrief discussions (Fanning & Gaba, 2007; Neill & Wotton, 2011; Shinnick, Woo, Horwich, & Steadman, 2011). Formal facilitated debrief presented a significant logistical challenge within the module due to the cohort size, low staff to student ratios and limited technical capability of simulation equipment; no facilities to enable capture and play-back; no designated space for debrief; demand for specialist facilities and number of hours available for teaching. In addition to these challenges, one of the most significant limitations was the lack of actual clinical experience of the students, limiting their ability to immerse themselves in role play. By not having any real clinical experience on which to draw, the students were sometimes reticent to immerse themselves in the scenario as they were unsure of their role. This then required the tutor to be physically involved in the simulated scenario to ensure that students were effectively enabled to complete the scenario.

As discussed in Chapter 1, professional practice is multifaceted and underpinned by a number of principles, standards of proficiency (HCPC, 2013) and professional values (CSP 2011). Not least of these are communication and working in collaboration with other health and social care professionals as well as patients and service users. This lack of realism of role play within simulation, coupled with the lack of opportunity for observation, play-back and facilitated reflection in- and on-action, could have potentially hampered the development of clinical reasoning skills and may have contributed in part to students reporting a lack of preparation for clinical placement.

7.2.2 Self-Assessment of Clinical Ability

The second aim of this study was to ascertain whether the redesign of the module and the inclusion of learning technologies better prepared students for clinical practice in the field of cardiovascular-respiratory physiotherapy, when assessing their own abilities. Specifically, this study was interested in whether there was a demonstrable difference between the application of different L&T interventions and a student's confidence in their clinical abilities. Self-assessment scores after the initial L&T intervention showed a difference between the traditional and learning technologies group; with the average scores being higher in the traditional teaching group compared to the learning technologies group. However, this was not statistically significant. By comparison, the distance travelled from baseline for all groups in Year 2 was significant. This demonstrates that students perceived an improvement in their abilities to assess, identify problems and manage a clinical situation appropriately following their initial L&T intervention, irrespective of whether the approach included technologies or was more traditional. Again, as with the MCQs, there was an additional gain following crossover teaching, but this was relatively small; with no difference being seen between the intervention groups.

The relatively lower self-assessment scores for the L&T groups that initially received the learning technologies was demonstrated in both cohorts. Whilst it is recognised that these results are not of statistical significance, when coupled with the higher respective MCQ scores seen in the learning technologies groups following initial L&T intervention, the findings raise the question as to why an increased knowledge gain demonstrated by MCQ scores did not necessarily translate to a perceived increase in confidence in ability. This finding is at odds with Hawkins et al (2012) who demonstrated improved accuracy of self-assessment with medical students following the introduction of benchmark videos. Whilst Hawkins et al (2012) demonstrate the effective use of benchmark videos for students to assess their ability against a particular psychomotor skill, the research does not explore how students extrapolate their overall ability or application of knowledge to different contexts. This study therefore provides new insight into how non-instructional/non-procedural video resources influence students' assessment of their own ability. More research into the role video resources have in facilitating self-reflection in an applied context is warranted; and is discussed in section 7.7.

Reflection is a skill that is fundamental to the process of clinical reasoning; both reflecting on-action and reflecting in-action (Edwards and Jones, 2007). The aforementioned lack of facilitated reflection within the module or debrief following the simulated scenarios may have influenced how students reflected on their own clinical ability. This lack of facilitated debrief may have therefore contributed to the reported anxieties expressed by students, leading to requests for additional case studies to enable better preparation for clinical placement; and may offer some explanation for the lack of relationship between self-assessment scores and module mark.

7.3 The Student Learning Experience

Qualitative data from students highlighted connections between the variety of activities and resources, improved engagement and learning. This was reinforced by the closing of the module mark gap seen when CVR was compared to other specialism modules.

Students positively associated interactivity and engagement; differentiating their experience of the CVR module with those of comparable specialism modules running concurrently. Interestingly, they seemed to talk in general terms about the experience of the module as a whole; not specifically the learning technologies, despite their awareness of the study aim. It could be argued that the technologies were integrated fully within the module and hence were not seen in isolation, separate to or detracting from the module learning experience as a whole. This mirrors the literature in relation to the use of learning technologies and the need for decisions to be pedagogically led not technology driven. Further reinforced by this study is the need to ensure that any learning technologies utilised should not be the primary focus of the L&T activity, or indeed detract from learning. Instead, students indicated that simple, accessible technologies that engaged them meaningfully in the subject matter resulted in a positive learning experience. Learning technologies that are seen as a 'gimmick' or adrift to the curriculum were not seen as engaging or valuable. Whilst students clearly valued the variety, this did not overshadow their primary focus: learning. Students did not want variety for the sake of it; they wanted a varied approach to L&T that increased their engagement with the subject matter itself and facilitated learning. This provides a new dimension to our understanding of the importance students place on engagement, and how this is seen as the gateway to learning potential.

Furthermore, all focus groups discussed the various learning technology resources in the context of different learning styles, with an acknowledgement that they engaged more with some resources than others, based on their own preference. Some students explained how they adapted resources to better align to their way of learning. For example, one student preferred to read the audio transcripts than watch and listen to a screencast presentation. Whilst there were discussions as to the need to offer a variety of formats and cater for the range of learning styles, there was awareness by the focus group participants that it would not be practicable to create each resource in numerous different formats to account for all individual preferences. This finding offers insight into the value of providing different formats of resources for students, where possible so they can choose which format to engage with that best supports their learning. This is arguably more achievable today. As technology continues to advance, so too, does web accessibility software such as the accuracy of voice recognition and the provision of closed captioning or full transcripts. It is therefore far easier now, and far less time consuming for academics to provide resources in different formats. For example, converting a previous PowerPoint lecture (with or without notes) into a screencast with accompanying transcription of the audio increasing the accessibility of the resources produced.

These discussions around resource format do highlight the importance of ensuring the accessibility of any L&T resource produced. All audio-based resources created within this study included written transcripts. As can be seen in Table 5.1, 19% of the study cohort disclosed a disability; this ranged from dyslexia, to hearing impairments, physical disabilities and mental health needs. Table 5.3 outlines the demographics of the focus group participants where design and accessibility of resources was explored in more depth. It is worthy of note that over 50% of the focus group participants had disclosed a disability.

In addition to variety, students commented positively on the interactive nature of many of the group activities. Coupled with the positive association of interactivity was the reinforced need for validation and provision of feedback from tutors on any work created by such group work. This is not surprising or unreasonable as, despite a general trend towards more active learning and a constructivist approach within HE (Albanese and Mitchell, 1993), students still perceive academic tutors as those possessing greatest knowledge and experience. Hence there is an expectation that tutors will provide guidance as to the quality of the outputs of group work and student created resources. This is particularly so if the output of the group work is to produce a large, shared learning resource for all students to utilise and apply to their own professional development.

As discussed in Chapter 2, the challenge with a constructivist approach to learning is the foundation on which meaning is created, applied, reconceptualised and transferred to a range of different contexts. The use and timing of these student-led activities therefore needs to be considered when designing a curriculum to ensure sufficient knowledge and skills exists in order to consolidate and build new knowledge. Despite the module within this study being in the second year of a three-year programme, the expectations of autonomous learning needed to take account of the level of pre-existing knowledge. One focus group raised a concern about a session's group activity that occurred early within the module. This session consisted of students working in groups to explore a topic previously not covered. Due to the lack of knowledge, skills or experience in this area, and limited guidance from the tutor, the students reported that they found the session to be a negative learning experience. Whilst this is only one example, it mirrors the aforementioned insight gained, that variety, active learning and interactivity, whilst seen as important by students, only carries merit if designed to support the gradual scaffolding of knowledge and skills; and is encapsulated by appropriate facilitation and structured feedback.

The response from focus group participants about sufficient instruction and facilitation resonates with comments from the preceding cohorts in relation to topics that were hard to understand and teaching approaches that they felt were not effective in facilitating greater understanding. Designing appropriate learning opportunities through the use of interactive activities therefore needs to take into account the baseline knowledge of students and the foundations on which they are building upon; and to consider the sequencing of a range of constructivist activities. Moving to constructivism too early in the module, or in the context of some hard to grasp topics, before the students have a foundation knowledge on which to draw, is likely to disengage students and further. Students indicated not only a need for variety, but careful consideration as to the construction of the learning experience overall. This suggests a balance between cognitivism and constructivism needs to be struck. Social cognitive theory and the process of demonstration, modelling and feedback (Chandler & Munday, 2016) to acquire and consolidate knowledge, supports the assertion by students that they need more direction on some elements of the curriculum initially. This reinforces that facilitation, formative feedback and collaborative dialogue opportunities are needed, to enable students to situate their knowledge and apply to different contexts (Kolb, 2014).

7.3.1 Assessment for Learning

Student responses in relation to formative and summative assessment activities featured strongly within the qualitative aspect of the study. Whilst it is acknowledged that exploring student experiences of assessment was not a primary objective of this study, formative and summative assessment activities were purposively designed, so it was important to elicit information from participants about assessment. When interpreting the quantitative and qualitative findings, issues such as 'assessment for learning' and 'authentic assessment' featured heavily, enabling the researcher to create meaning.

A strong content element of all of the focus groups was the role of formative assessment, and its ability to help identify strengths and weaknesses, and plan ongoing development needs. Focus group participants asserted that more incremental, meaningful formative and/or summative assessment tasks throughout the module would help them identify their strengths and weaknesses and tailor their self-directed study accordingly. What also became apparent, both through the focus groups and the module evaluation feedback, was that students could not directly link the relevance of the written task to clinical practice. As outlined in section 2.2.6.2, the written assessment task was based around a case study and required students to explore the literature surrounding their chosen intervention for that case study. The indications from students was that it was the format of the task that was not seen as relevant or able to facilitate learning, rather than the content of the task itself.

Assessment has long been linked to greater learning (McDowell, 2013 citing Marton et al, 1997; Sambell et al., 2013), but more recently assessment for learning and authentic assessment activities have gained greater relevance across the HE sector (Knight, 2012) Engaging students and supporting their development through meaningful assessment has also been seen to afford greater opportunities for students to reach their potential and support retention (McDowell, 2013). In addition, the balance of formative and summative activities has been identified as a key component of this. The student feedback in relation to the module's formative and summative assessment activities clearly indicates a disconnect with the written assignment and the value placed on the formative activities. This suggests that greater meaning was attributed to the formative activities with a poorer understanding of how the written assignment supported the transference of learning to a clinical context, despite this being case study based.

When considering the feedback from the students in relation to both the need for greater clinical application, and the value of formative assessment activities that help focus learning, assessment re-design is perhaps suggested. This is supported by the literature on assessment for learning and the role of authentic assessment as a means of engaging students and optimising learning outcome (Gadsby and Beere, 2012). As previously discussed, results from this study show a disconnect between assessment marks and student self-assessment of competence. These findings coupled with the discussion in section 7.2 as to the model of clinical reasoning taken, further bring into question the authenticity of the module's assessment task relative to contemporary CVR physiotherapy practice. This is a wider challenge for health education programmes: standardising university-based assessments is required to enable consistent and equitable assessment of all students against identified marking criteria; however, this in turn can limit the realism of the situation by constraining variables. The use of simulation is widely acknowledged as providing appropriate assessment opportunities (Issenberg & Scalese, 2008), however, findings from this study suggest greater authenticity is needed.

Assessing each student against a randomly selected, previously unseen case study provided the examining team with a snapshot of the competence of the student at that moment for that one case study. Whilst this assessment task did not provide a comprehensive, longitudinal insight into the student's ability, it did enable the student to be measured against the Learning Objectives of the module. The insight that this summative assessment task provided into the overall competence of a student in the field of CVR is therefore arguably limited. However, it was never intended to be anything other than a measurement of the students' ability to assess and treat a cardiorespiratory patient at a specific point in time. This standardised task provided an effective measurement against the SoPs set by the HCPC. This measure of competency to perform a clinical examination of patient presenting with cardio-vascular or respiratory compromise under exam conditions may also account for why there is no apparent correlation between the assessed and self-assessed measures.

The responses provided by the students, both in the focus groups and via the free text within the module evaluation, about authenticity of assessment tasks caused the researcher to consider alternate assessment task design. Indeed, consideration could be given to the designing of a graduated patchwork assessment task (Jones-Devitt, Lawton and Mayne, 2016). Patchwork assessments consist of a number of discrete components undertaken over time, where each of these components contribute to a wider activity that provides overall unity. The 'patchwork assessment only being finalised retrospectively, when they are 'stitched together' (Winter, 2003).

In the context of the module within this study, the patchwork model could be adapted to a 'practical patchwork' assessment could take the form of a range of clinical scenarios in which a student is assessed; with an overarching reflection as to their development of professional and clinical reasoning skills throughout the module. For example: the first 'patch' could be an early simulated case study where a student is required to undertake history taking and the clinical examination of a cardiorespiratory patient. A summative mark and feedback would be provided on the history taking aspect; with formative feedback being provided for the clinical examination element. This patch could be followed by a further simulated case study a few weeks later where the summative mark and feedback would be provided on the clinical examination element; with formative feedback provided on the history taking aspect. Later, students could be given another simulated case study and asked to identify and prioritise problems and/or demonstrate therapeutic interventions. The final patch could consist of a viva to discuss in detail the management strategy for one of the previous case scenarios, chosen by the student. For each patch the student would be encouraged to enter into an active dialogue with the examiner, discussing what they know and identifying if/when they were working beyond the scope of their knowledge. These patches would then be drawn together by an overarching reflection of professional development and clinical reasoning throughout the module.

The above example has arisen from the researcher reflecting on the perceptions of the students as to the value of early formative and/or summative assessments, the need for authentic and meaningful assessment tasks as well as a desire by the researcher to improve the clinical reasoning abilities of students, better preparing them for clinical practice. By proposing a more dynamic and graduated approach to assessment, incorporating formative and summative elements as well as an active dialogue that allows the students to seek to further support, guidance and/or assurance, could be argued as being more authentic. It is the insights drawn from the focus group discussions surrounding assessment that have led to this novel assessment approach being identified.

Further research is needed to assess whether a practical patchwork assessment model would enhance the development of clinical reasoning, better facilitate the application of learning to clinical practice , and meet students' requests for greater exposure to a range of case studies, without overly increasing the assessment burden.

7.3.2 Learning Technologies

What became apparent from the focus groups was a lack of consensus as to the relative value of specific learning technologies and/or resources; with the exception of simulation and video. Students varied in their opinion of the additional benefit to learning that the 3D resources or the inclusion of iPads afforded. Statements ranged considerably; however, it was possible to distil an element of commonality from the discussions. Most obvious was the value of being able to revisit, repurpose and reutilise the resources. The online resources were received positively due to their open, accessible nature and the 'bite-sized' way in which they could be utilised to augment learning at times convenient to them. Indeed, some students felt they offered a much better basis on which to learn than the previous potentially over-facing workbooks. This mirrors what has already been discussed in relation to video content.

When discussing the 3D anatomy resources, most focus group participants agreed that they would sacrifice the 3D element for more readily accessible 2D video-based images that they could access themselves outside of class; enabling them to take ownership of when and where they learned. This was on the proviso that there was additional narrative providing relevant clinical application. Ultimately, accessibility, variety and the ability to revisit meaningful, authentic resources tailored to the module emerged as of importance to students, rather than identifying one resource as being of greater value than another. This is supported by what is known about the value of video-based resources outlined in section 6.2.

Further considerations for the integration of learning technologies, based on student feedback, is the need for flexibility or adaptability so students can engage with them in a way that is meaningful to them. Personalised learning is a term that refers to the range of L&T approaches required to best enable each individual student to reach their potential (Prain et al, 2013) taking into account the differing learning needs and interests of students. Whilst it is not feasible to create multiple formats of each learning resource, this finding highlights the importance of ensuring that the approaches taken and the resources created to facilitate learning vary and incorporate different educational backgrounds, cultures and learning styles in order to optimise the potential for personalised learning (Leadbeater, 2005; Hummel, Manderveld, Tattersall, & Koper, 2004). Whilst the value of personalised learning is known, further research to examine what types of resources stimulate and optimise student engagement, and how they can be personalised to enhance opportunities for attainment is warranted.

7.3.3 Learning Environments

The potentially disruptive nature of technology and the false assumption that all students are 'digital natives' in a L&T context should not be overlooked (JISC, 2015). Physical learning spaces and their impact on the learning technologies being utilised within them received significant feedback from students both within the focus groups and via the module evaluation forms.

The use of 3D, VR and AR received the most mixed feedback from students. Whilst many could see their potential value in enhancing learning, the requirement to use a small, purpose-built room for the immersive 3D anatomy experience significantly impaired the student learning experience. The 3D resources that were created enabled the student to 'walk around' and manipulate the lungs, but this could only be undertaken individually with cumbersome headsets; whilst others sat in the dark and observed. The result was that those students observing were precluded from taking notes due to poor lighting. Some students reported that the scale of immersion alongside the motion experienced when structures where manipulated could be a little disorientating. Also, students with visual impairments or even a requirement to wear glasses that did not fit under the VR headsets did not find the VR of little educational benefit. As previously mentioned, the feedback in relation to the 3D lungs was that students would have preferred less advanced technology, and indeed 2D resources, and for these resources to be more accessible on their own devices so that they could revisit them.

The negative feedback in relation to the VR space constraints is perhaps of less significance at the time of writing. All focus group participants acknowledged the value of these resources in developing understanding of the core underpinning theory; they just found the space and limited accessibility preclusive. Advancement in VR and AR technologies and the platforms that can run these such resources have proliferated significantly in the last two to three years. 3D and VR resources are now much more accessible; with most smart phones, tablets, laptops and PCs now able to run such applications and programmes. The use of 3D VR in this study therefore demonstrated a viable proof of concept; but it was arguably constrained in its efficacy by the technological constraints at the time. The use of 3D and VR resources now have the potential for much more widespread application in L&T, although limitations regarding accessibility for students with visual impairment should still be carefully considered.

Augmented reality (AR) was also trialled within this study. As outlined in Table 2.6 this consisted of a video of patient actor providing a subjective history and presenting with abnormal clinical signs. This video was then superimposed over a mannikin during a simulated case scenario using an AR app installed on the in-class iPads. The implementation of this was varied; with responses from focus group participants being that some tutors used it, and some elected not to. The reasons given by fellow academics for not implementing this aspect of the study were related to two factors: firstly, staff confidence, and secondly, the limitations of the simulated space where multiple scenarios were being enacted simultaneously, leading to significant background noise. Whilst the actual experiences of students using the AR was sporadic, when discussed within the focus groups, many participants requested expansion of this approach to help create a greater sense of realism and aid transference to clinical practice. This aligns with the assertion of students within the study that video resources provide the greatest potential for learning and transference to practice. Whilst it was impossible to draw conclusions as to the value of AR for this specific use, advancements in technology coupled with student feedback supports consideration of how the use of AR could be expanded, to enhance the experience of the simulated clinical environment.

The use of iPads to support group work garnered feedback in relation to device to student ratio, as well as the types of activities being asked of the students. Specifically, the expectation that students would collectively engage with a resource at the same pace was highlighted as an oversight. In addition, one focus group identified that the devices could be distracting as they were seen as a novelty. The issue of novelty is perhaps of less relevance at the time of writing in light of the proportion of the student population that now has access to a smartphone or tablet (Osborne, Dunne and Farrand, 2013).

When using the iPads as part of group work in class the researcher had not considered the implications of multiple audio outputs simultaneously. Whilst the group work requiring collaboration and the creation of online resources in text format via the iPads was well received, the need for clearly defined break out spaces, earphones or quiet areas was identified as key to their accessibility and functionality. Screen size, lack of mirroring infrastructure, as well as limited small group spaces with accompanying AV capabilities contributed to the identified limitations of using these devices in a collaborative way.

The findings described above highlight the criticality, to the student experience, of the flexible functionality of learning spaces in accommodating the inclusion of media-based and innovative learning technologies. Technology has moved at such a pace even since the start of this study; and it continues to do so. It is therefore impossible to predict what learning technologies will feature in 5-10 years' time. However, building flexible, agile spaces that can adapt and can be reconfigured to a range of L&T activities / approaches needs to be embedded into design principles and refurbishment plans. What emerged from this study was rather than the potential for technology to disrupt the learning experience, but the realisation that traditional physical learning spaces and lack of virtual infrastructure can constrain and even stifle innovation and creativity. Student feedback indicates that the physical environment has as much potential to disrupt the learning experience as the technologies utilised within them; and consideration of the interplay between these two elements needs to be incorporated when designing in-class and collaborative learning experiences. It is this perspective of the physical infrastructure constraining the utilisation of learning technologies; and that digital learning opportunities should drive the design of physical learning spaces that provides new understanding in this area.

7.4 Visual Analysis of Focus Groups

The choice to use video capture in addition to audio recording was initially implemented as a back-up to allow the researcher to revisit the discussions and identify key interactions that had been missed during the focus groups in the absence of a note taker or moderator. However, this quickly evolved into being much more integral to the analysis process. What resulted was a more structured and detailed use of video analysis in conjunction with the process of thematic analysis.

Various biases have been identified during the interpretation of focus groups discussions such as the potential for a participant to be dominant, overstatement of issues and social acceptance (Greenbaum, 1998). The integration of visual analysis enabled the researcher to consider these potential biases more overtly and observe how they influenced the flow of discussions. Video analysis became an equal part in the identification of themes. It enabled the researcher to consider the relevant 'weight' of a topic through repeated observation of body language and eye contact in conjunction with what was being said. For example, the researcher was able to identify when respondents were seeking assurance and/or validation from their peers in relation to their comments, the use of affirmative body language (such as nodding) and by how many in the group, and disengagement of others through lack of eye contact or interaction. It also enabled the researcher to observe group dynamics and consider the general environment. Whilst it is accepted that the of role note-taker could be to document such interactions and nonverbal communication etc (Onwuegbuzie et al., 2009), it would have been impossible for the researcher to compile such a detailed observed narrative whilst also facilitating the focus group discussions. Observations made via video analysis were reviewed and revisited; akin to reading and re-reading transcripts to improve familiarity (Ritchie et al., 2014). This new method of data analysis enhanced confidence in the interpretation of the data.

Visual methods and video-based resources featured very heavily within the development of the L&T resources. It was therefore understandable for the researcher to consider video recording as a means of capturing the focus group discussions. Whilst some evidence suggests video capture of focus groups can potentially stifle discussion (Kreuger, 1998), this was not evident within this study. The use of video has been reported as being seen by some as intrusive; with some participants reportedly feeling self-conscious (Krueger, 2014). However, none of the focus group participants voiced any objections to the use of video capture. The reticence for video capture may be an issue that is becoming less apparent due to changes in society. Posting of video-based media to platforms such as Facebook, Twitter, Instagram (Eynon and Malmberg, 2011) is becoming commonplace in everyday life.

An additional benefit of video analysis was the ability to observe researcher behaviour. As previously discussed, the researcher had considered structural functionalism and its potential role in influencing student involvement in the study. It was possible, due to video capture, to observe when participants were seeking affirmation from the researcher or indeed subconscious body language of the researcher that may have influenced discussions. Video analysis therefore allowed the researcher to observe her own behaviour and consider more overtly her role in steering discussions and responding to group dynamics. One observation made through video analysis was the dynamics within the smallest focus group. It became evident on analysis that the contributions of the group were skewed towards two of the participants. These participants appeared to agree predominantly with each other to the exclusion of the other participant. It subsequently led to the researcher to consider how best to ensure all perspectives are incorporated and valued; not just those where there is a strong level of agreement between a small number of participants. On reviewing the videos, the researcher observed a shift in the way in which the dialogue was facilitated; moving from a freeflowing discussion in the other focus groups, to a more directed discussion where participants were specifically invited to contribute. This afforded the ability to not just note the balance of conversation facilitated by the researcher, but also the body language of both the researcher and the participants.

Further research is required to develop and standardise this documented process of analysis and to evaluate its contribution to the thematic analysis of focus group interviews. This is elaborated in Section 7.7.

7.5 Study Limitations

Commentaries on qualitative research suggest that there can be many ways in which distortions in explanations and outcomes can creep into analyses, very often because of a lack of transparency in all the associated processes. For example, it is not always clear whether the research has been conducted in a way that inadvertently constrains viewpoints through sampling strategies or researcher interpretation bias, whether participants have been steered towards a common conclusion through the way in which the research in conducted, or whether the results are truly representative of the participants views (Roulston and Shelton, 2015).

Whilst it is acknowledged that bias exists and cannot be fully eliminated in qualitative studies, methodological rigour needs to be considered at various key stages to ensure bias is eliminated or minimised where possible. As outlined in the preface, the pre-cursor to this study was the re-design of the module in a collaborative partnership with students. Whilst this research study itself was not collaborative in terms of being constructed through action research or co-design of the methodologies (Foster, 2014), the concept of virtue ethics steered some of the within-research methodological choices. Researcher reflexivity is an important component of qualitative research, considering not only the field and the relationship with participants but also the researcher's own world view.

However, the role of the researcher as the Module Leader is of key importance in this study. This dual role could be seen as acting as a conflict of interest, and one that limited the students' ability to give true consent to be part of the study. However, the dual role situation was made available to the ethical reviewers of the study; and the study received University ethical approval. Students were provided with written and verbal information about the study and given the opportunity to ask questions prior to written consent being requested. It was also made clear to students that their learning, teaching and assessment experience would not be negatively affected if they did not consent, or withdrew consent at any point in the study. It is recognised that any perceived conflict could have been avoided if another colleague had been appointed as Module Leader and point of contact for the students for the duration of the study, but this was not practicable due to resource constraints.

Utilising a crossover design was seen as the only viable method of delivery in light of attempting to compare L&T approaches within a compulsory module, whereby the summative assessment mark would contribute to degree classification. This was discussed at length with the researcher's supervisors prior to designing the study. In order to answer the research question: does the inclusion of learning technologies and video-based resources have a greater impact on knowledge and understanding than traditional teaching methods, it was deemed necessary to compare traditional teaching approaches with the approach that included learning technologies. Furthermore, it was necessary to ensure that no student was unduly disadvantaged by not receiving one form of L&T. There were also constraining factors such as cohort group allocation and timetabling restrictions. The chosen design was therefore shaped around the constraints of the programme delivery to ensure no disruption to students' timetable occurred as a result of this study. This aligns to the real-world research premise outlined in section 4.2 which recognises variables are present that will likely influence the outcome of a study; but represent reality.

Results showed that additional demonstrable learning gain was limited following crossover; with discussion exploring the value of not revisiting topics in the same manner as initially introduced. However, the methodological imperative of this study was to compare different approaches: traditional with learning technologies. Introducing, for example, a spiral curriculum approach within this study would have made such a comparison impracticable.

Not fully considering or evaluating the impact of placement on learning is a significant oversight of this study. In the statement questions within the self-assessment, there was the potential to identify those students who had gained CVR experience whilst on placement, and to triangulate the impact this had on both their self-assessment and the module summative mark. This might well have generated more insights about the impact of clinical placement and experience on clinical reasoning and the preparation for the module assessment task.

The lack of focus group interviews following the second year of the study is disappointing. One of the decisions made when redesigning of the module was to condense the duration of the module. The previously 'long, thin' module that spanned both semesters became a 'short fat' module that was completed after Semester One. Once the module was complete, students then went on clinical placement, followed by the Easter break. The earliest opportunity to undertake the focus groups was nearly three months after completion of the module. The consequence of this delay between completing the module and information about possible participation in focus group interviews seems to have been a lack of uptake by students. Whilst this lack of second cohort focus groups precludes the possibility that more or different insights might have arisen, module evaluation scores and free-text comments mirrored those of year one. As the study protocol had not changed, the L&T experiences of students would more likely be similar. Furthermore, data saturation was reached as part of the first year of focus groups, offering a level of confidence in the conclusions drawn.

7.6 Conclusions

Chapter 1 of this thesis presented the evolution of physiotherapy practice and the developments in Higher Education impacting on undergraduate physiotherapy education. Clinical Reasoning is fundamental to both physiotherapy practice and physiotherapy education: it is shaped by changes in how we practice and it in turn shapes how we teach and assess it. The subsequent sections of this chapter distil the key findings from this study relative to the themes that have run throughout: clinical reasoning within physiotherapy practice; physiotherapy educational approaches, including the utilisation of learning technologies; and the student learning experience.

7.6.1 The Evolution of CVR Physiotherapy and Resulting Educational Developments

Over the last 15 years there has been a significant change in the way CVR Physiotherapists work, moving from predominantly being based in the acute care setting, into rehabilitation, prevention and the management of long term CVR conditions in conjunction with other Allied Health Professionals (England, 2013; 2017). This shift towards rehabilitation and enablement and the long-term management of CVR conditions has arguably resulted in greater alignment to the activity limitation and participation domains of the ICF. Effective long-term management strategies require the development of effective therapeutic relationships through meaningful communication, collaboration and the identification of patient-centred problems and goals (Miciak, Mayan, Brown, Joyce, & Gross, 2018). This altered clinical focus has implications for both the content and methods of teaching within undergraduate Physiotherapy programmes, as well as the assessment strategies used.

7.6.1.1 The Development of Clinical Reasoning Skills

Whilst this study showed there was no demonstrable difference in learning between traditional L&T approaches and those that incorporated learning technologies, the overall attainment of students on completion of the module improved, when compared to other specialist modules taught at the same time. This provides evidence that the module re-design was effective in the development of knowledge, understanding and clinical reasoning as assessed by the module's marking criteria.

It is clear from the module evaluation and focus group discussions that simulation and video-based resources are seen by students as providing a bridge between classroom-learning and clinical practice. However, it was also shown that students feel that more could be done to better facilitate application of learning into practice. One of the suggested means of achieving this is the increased use of case studies and simulated scenarios. This suggestion brings into question whether the module was truly assessing clinical reasoning, or whether the assessment task was merely a measure of competency. In order to be a competent professional, it is necessary to be able to assess a situation, determine the nature and severity of the problem and call upon the required knowledge and experience to deal with the problem, making reasoned decisions to initiate, continue, modify or cease techniques or procedures (HCPC, 2013). The rationale of students reporting that they would like a greater variety of case studies to better prepare them for the simulated assessment task therefore brings into question whether the module's learning and teaching and indeed the assessment facilitated the development of clinical reasoning skills, or just psychomotor skills and the ability to clinically examine a patient in a structured manner.

Simulation was implemented within the module without formal facilitated debrief. This did not reflect recommended best practice as outlined by the literature (Issenberg & Scalese, 2008), but was due to logistical and technical constraints. As such, the way simulation was delivered within the module was seen to be sub-optimal by the teaching team; but the optimum that could be achieved within the circumstances. On reflection, the delivery of simulated learning within the CVR module, would benefit from further review and redesign.

The use of self-assessment scores relative to module mark and formative assessment tasks (MCQs) offers further insight into the challenge of demonstrating improvements in learning in healthcare education research. Self-assessment scores did not correlate with any other measure used within the study. This is in keeping with the literature and the accuracy of self-assessment of novice practitioners and students (Blanch-Hartigan, 2011) However, these scores also did not reflect the assertions of some studies that younger graduates are more likely to score themselves higher than older graduates when self-assessing their level of competence (Hadid, 2017). Whilst the debate surrounding the accuracy of self-assessment and its value as a predictive tool and correlation to assessed performance continues, more could be done to incorporate facilitated debrief and reflection on and in-action within simulated activities. This may aid in the development of competent practitioners who can move beyond concrete experiences and apply their clinical reasoning skills in scenarios not previously experienced, and also more accurately reflect on their clinical abilities.

7.6.1.2 L&T Approaches

It was not possible to determine which L&T approach was the most efficacious, or indeed identify significant improvements in learning following the revisiting of topics. When considering the development of CVR knowledge and understanding through the various learning approaches employed with the module, as discussed in Chapter 2, it could be argued that in order to develop understanding beyond that which was already gained after the initial L&T, different L&T approaches should have been utilised at crossover. By changing the way in which the topics were explored, or incorporating a wider variety of case studies, different resources and/or facilitated reflection, greater potential for learning could have be afforded. A spiral curriculum is one such approach that could have afforded improved learning and the development of clinical reasoning. A spiral curriculum requires an iterative revisiting of topics, rather than simply repeating the topic being taught (Harden, 2009). The premise is that each successive learning encounter builds on the previous one (Johnston, 2012). Researching the most effective methods of L&T to facilitate the development of clinical reasoning within a spiral curriculum framework would provide useful insights for physiotherapy education programmes, and is discussed in the subsequent section of this chapter.

Assessment was seen by students as key to the learning process with more, early summative and formative assessments suggested. Alongside this was the request for assessment tasks to be more authentic and relevant to clinical practice. These recommendations by students, in conjunction with learning from the L&T outcomes of this study, provide an opportunity to design assessment tasks that better reflect the breadth of contemporary CVR clinical practice. In doing this, a wider range of case studies are likely to be utilised; and the provision of feedback facilitate reflection. By integrating these clinically relevant assessment tasks earlier, assessment for learning could be strengthened.

7.6.1.3 The Student Experience

Students reported a more positive learning experience compared to modules that used traditional teaching methods. The inclusion of the various learning technologies, resources and activities were reported by students as increasing their engagement, which they associated as improving their overall module experience and enhancing their learning. However, this latter assertion was not supported by the quantitative results from this study. Students indicated that the use of learning technologies afforded greater opportunities for variety of L&T. Variety was seen positively, with students reporting the active nature of the L&T activities and the level of engagement this elicited, above that seen in other modules. Furthermore, students considered variety in format and approach as positively supporting accessibility and accommodating different learning preferences. Students identified being able to revisit and adapt resources to best meet their learning needs and lifestyles as a benefit of having a range of resources and formats.

This study supports the literature base that pedagogy must be the overriding factor in curriculum design, otherwise the learning technologies have the potential to distract or even detract from the learning experience (Kirkwood and Price, 2014). However, what was reported within this study was that physical spaces have the potential to distract and detract from learning. The findings highlight that physical learning spaces, and the infrastructure supporting the delivery of L&T, should not be overlooked when planning to integrate learning technologies, as these have the potential to limit functionality and application. Ultimately the two spaces (physical and virtual) are synergistic. This study provides new understanding of the importance of designing physical learning environments so as not to constrain innovation or the use of learning technologies within those spaces.

7.7 Research and Pedagogic Implications

7.7.1 Pedagogic Implications for CVR Physiotherapy Education

7.7.1.1 Video-Based Resources

A range of video-based resources were utilised within this study. These ranged from screencasts introducing different pathologies, 3D depictions of anatomical structures and physiological processes, demonstrations of therapeutic interventions and AR patient case studies. The purpose of these videos was to improve understanding, enable visualisation of key processes, functions and clinical presentation; and apply this knowledge to clinical practice. Whilst improvements in student attainment was seen, what remains unclear is to what extent the video-based L&T resources contributed to learning, and the application of that learning to clinical practice.

Evidence suggests that video resources enable the development of practical and psychomotor skills, but what is not known is their value in unlocking troublesome, components within a specific professional Threshold Concept. One of the Threshold

Concepts identified by students was the clinical presentation associated with pathophysiological changes; with the underpinning physiological changes being bounded to changes in clinical signs and symptoms. Depicting these pathophysiological changes through the development of visual resources was identified by students as a means to help bridge the understanding between theory and practice. However, further understanding is needed of the impact video-based resources can have in facilitating greater understanding of complex and or troublesome topics. It is clear that students didn't see the learning technologies or specific resources in isolation, so it is important that those designing curricula do not either. Consideration of the purpose and design of video-based resources and identifying the L&T activities that sit around them to reinforce the bridge between knowledge and application is therefore advised.

7.7.1.2 Simulation and Facilitated Debrief

Students recognised the value of simulation but report a lack of realism. This exemplifies the challenge of immersing novice physiotherapists in role-play and simulation. Overlaying AR patients or patient actors has the potential to provide some additional reality. Opportunities exist to work with exiting local and national networks to develop a range of scenarios and AR videos that could be widely utilised in undergraduate programmes. If the purpose of the AR is to set the scene and provide a patient summary of their history, as well as provide visual cues, these resources could be purposefully designed to have utility beyond Physiotherapy education to wider health and social care professions.

It is acknowledged that much of simulation using SIMMAN does not provide the dialogue and narrative approaches that are fundamental to clinical reasoning. Increasing the breadth of simulated scenarios to better represent the range of situations and students might likely encounter a patient with CVR compromise is warranted. In addition, in light of changes to the profession and the move away from a 'hands on' approach, it is suggested there is a greater need for role play where students can develop their communication, interactive and collaborative strategies and enhance their clinical reasoning skills further supporting the profession towards a more integrated, participatory approach.

Furthermore, meaningful facilitated debrief after a simulated learning experiences needs to be incorporated into curricula. This has previously been reported as being a challenge in large student cohorts due to resourcing and physical infrastructure constraints. Technologies are such that it is now possible to live stream simulated activities to a large group of observers watching remotely. Accessible recording and play-back functionality within these live streaming platforms enables key moments to be re-watched and discussed. It is therefore now possible to deliver meaningful facilitated debrief to large groups of students.

7.7.2 Future Research

7.7.2.1 Visual Analysis Method

Visual analysis methods were developed within this study to support thematic analysis of focus group discussions. This process is seen to be of value in enhancing the richness of the analysis process and the results generated. Video analysis was used not only to supplement the audio transcription but also to cross-reference, triangulate and at times moderate the conclusions being drawn. Whilst development and refinement of this technique is required through further research, utilising this combined approach to focus group data analysis could provide greater insight into opinions, behaviours, levels of agreement and dissensus; and should be considered more readily. It also provides opportunities for researchers to review and reflect upon their facilitation skills. Capturing these interactions on video enables a dynamic process of review and reflection to take place either individually or indeed facilitated by a research supervisor. The latter mirroring the process of video playback and debrief identified as effective in developing practice as a result of simulated activities.

Video capture and analysis also affords greater opportunity for participant verification. Often, verification requires members to check results for accuracy and/or resonance (Morse, Barrett, Mayan, Olson, & Spiers, 2002), however the value of this has been brought into question (Birt, Scott, Cavers, Campbell, & Walter, 2016). Opportunities present for using the video as part of the verification process alongside asking participants to review a textual interpretation of the researcher.

Ways to test the rigour of this analysis method is to enlist additional analysts who have not participated in the focus groups, but who are familiar with the process of thematic analysis. These analysts would be asked to watch and re-watch the videos, observing and noting behaviours. Subsequent comparison of each researcher's interpretation based on video analysis would enable identification of any inconsistencies in interpretation process. The designed template (Table 4.7) could be used to note, code and attribute perceived relative strength of feeling alongside the verbal transcription requires. This template too, requires further investigation and refinement.

Visual methods of analysis are growing in relevance and prevalence with the proliferation of technologies that enable this (Denzin & Lincoln, 2008) Triangulation of verbal and non-verbal interpretation through visual means has the potential to provide much greater richness of interpretation and provide further confidence to the researcher that data saturation has been reached (Tashakkori & Teddlie, 2010). However, consideration must be given to the observation and analysis skills of the individuals undertaking the process and hence appropriate verification processes must accompany this method of analysis.

7.7.2.2 Patchwork Assessment

In light of student recommendations, opportunities to incorporate early formative and summative practical assessments within the curricula, that are representative of clinical practice, should be identified. Applying these assessment tasks to a patchwork assessment model (Jones-Devitt, Lawton, & Mayne, 2016) and evaluating the impact is merited. In the context of this CVR module, it is proposed that the patchwork model of assessment use simulated/role-play scenarios across a broad range of contexts undertaken at key intervals throughout the course of the module. This would afford students the opportunity to demonstrate a more longitudinal picture of their clinical ability and development, as well as providing a wider range of cases that represent the breadth of CVR Physiotherapy practice. Key to the patchwork assessment is the final, overarching reflection to 'stitch' the patches together. This final reflection activity would encourage students to consider feedback and their overall development throughout the module.

These changes could not only better represent clinical practice, but also engender broader clinical reasoning strategies such as narrative, interactive and collaborative. The provision of timely feedback on the individual patches would also promote reflection on-action. A recommendation of this study is therefore the design and evaluation of a new approach to the assessment of UG CVR clinical reasoning and decision-making in keeping with developments in CVR clinical practice.

7.7.2.3 The Future of Clinical Reasoning

A key challenge within any physiotherapy curriculum is reflecting and responding to the changing nature of healthcare services. As previously discussed, within the field of CVR, graduate Physiotherapists are increasingly likely to work in previously non-acute settings. It is this evolution of the way in which we as Physiotherapists are likely to be working in future that raises the importance of ensuring the clinical reasoning approaches taught within undergraduate education programmes are reflective of practice. Furthermore, the Topol Review identified that technological developments are likely to change the roles and functions of clinical staff in all healthcare professions over the next two decades (Topol, 2019). The recent global pandemic has acted as a catalyst in the adoption of some of these technologies, with CVR Physiotherapists moving to digital and online platforms to assess, rehabilitate and educate patients. Investigation into how these new ways of working are impacting on and changing our clinical reasoning processes and approaches is now needed. Only once there is a better understanding of how these digital health technologies affect the way we process information, interact with our patients and deliver therapy services, can we design physiotherapy curricula that facilitate the development of these skills and equip our graduates for clinical practice in the digital working world.

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Appendices

Appendix 1: MMAT Appraisal Tool (Hong et al., 2018).

Part I: Mixed Methods Appraisal Tool (MMAT), version 2018

Category of study designs	**Methodological quality criteria**	**Responses**			
		Yes	No	Can't tell	Comments
Screening questions (for all types)	S1. Are there clear research questions?				
	S2. Do the collected data allow to address the research questions?				
	Further appraisal may not be feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.				
1. Qualitative	1.1. Is the qualitative approach appropriate to answer the research question?				
	1.2. Are the qualitative data collection methods adequate to address the research question?				
	1.3. Are the findings adequately derived from the data?				
	1.4. Is the interpretation of results sufficiently substantiated by data?				
	1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation?				
2. Quantitative randomized controlled trials	2.1. Is randomization appropriately performed?				
	2.2. Are the groups comparable at baseline?				
	2.3. Are there complete outcome data?				
	2.4. Are outcome assessors blinded to the intervention provided?				
	2.5 Did the participants adhere to the assigned intervention?				
3. Quantitative non-randomized	3.1. Are the participants representative of the target population?				
	3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)?				
	3.3. Are there complete outcome data?				
	3.4. Are the confounders accounted for in the design and analysis?				
	3.5. During the study period, is the intervention administered (or exposure occurred) as intended?				
4. Quantitative descriptive	4.1. Is the sampling strategy relevant to address the research question?				
	4.2. Is the sample representative of the target population?				
	4.3. Are the measurements appropriate?				
	4.4. Is the risk of nonresponse bias low?				
	4.5. Is the statistical analysis appropriate to answer the research question?				
5. Mixed methods	5.1. Is there an adequate rationale for using a mixed methods design to address the research question?				
	5.2. Are the different components of the study effectively integrated to answer the research question?				
	5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?				
	5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?				
	5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?				

Appendix 2: MMAT Summary of the Clinical Reasoning Literature at the Outset of the Study

<table>
<tr><th>Study</th><th>Design</th><th>Participants</th><th>Measures / Analysis</th><th>Findings</th><th colspan="3">MMAT</th></tr>
<tr><td rowspan="6">Babyar, S.R., Rosen,E , Macht. Sliwinski M, Krasilovsky, G Holland, T. Lipovac, M (2003)

Physical Therapy Students’ Self-Reports of Development of Clinical Reasoning.</td><td rowspan="6">Survey</td><td rowspan="6">725 surveys sent to 19 Physio school in HE

156 respondents from 14 Physio schools (22% response rate)</td><td rowspan="6">Survey: 19 MCQs; 6 open Q’s
Survey not validated
Quant data descriptive only
No detail of Qual analysis</td><td rowspan="6">Students place an emphasis on needing a balance between clinical placement learning and classroom teaching
Written case studies useful to develop CR
Even spread of learners across Kolb's learning styles</td><td>SQ 1&2</td><td>√</td><td>√</td></tr>
<tr><td>4.1</td><td colspan="2">√</td></tr>
<tr><td>4.2</td><td colspan="2">√</td></tr>
<tr><td>4.3</td><td colspan="2">√ (not validated)</td></tr>
<tr><td>4.4</td><td colspan="2">N/R</td></tr>
<tr><td>4.5</td><td colspan="2">Descriptive only</td></tr>
<tr><td rowspan="6">Cruz, E.B., Moore, A.P., Cross, V. (2012)

A qualitative study of physiotherapy final year undergraduate students’ perceptions of clinical reasoning.</td><td rowspan="6">Qualitative</td><td rowspan="6">28 participants; 4 focus groups</td><td rowspan="6">Focus groups
Interpretive hermeneutics
Process of data analysis described
Member checked/peer reviewed</td><td rowspan="6">Identified 4 main themes:
CR is an instrumental process to develop theoretical knowledge and technical skills
CR is a clinician-centred process
CR is a knowledge-dependent process
CR is context dependent</td><td>SQ 1&2</td><td>?</td><td>√</td></tr>
<tr><td>1.1</td><td colspan="2">√</td></tr>
<tr><td>1.2</td><td colspan="2">√</td></tr>
<tr><td>1.3</td><td colspan="2">?</td></tr>
<tr><td>1.4</td><td colspan="2">√</td></tr>
<tr><td>1.5</td><td colspan="2">√</td></tr>
</table>

Study	Design	Participants	Measures / Analysis	Findings	MMAT		
Furze, J., Black, L., Hoffman, J., Barr, J.B., Cochran, TM., Jensen, G.M.(2015) Exploration of Students' Clinical Reasoning Development in Professional Physical Therapy Education.	Longitudinal qualitative	98 participants; 2 consecutive cohorts Data collected at 4 key points over 2 years for each cohort	Clinical Reasoning Reflection Questionnaire (CRRQ) – developed by researchers, not validated Clinical Performance Instrument: narrative comments from assessors	3 stages of CR development: Focus on self initially, compartmentalise, limited acceptance of response to situation Starting to recognise context; procedural; improved reflection on performance Dynamic patient interaction; situational awareness;	SQ 1&2	√	√
					1.1	√	
					1.2	?	
					1.3	√	
					1.4	?	
					1.5	√	
Gillardon, P., Pinto, G. (2002) A proposed strategy to facilitate clinical decision making in physical therapist students.	Longitudinal qualitative	25 participants;; 2 cohorts	Process/algorithm for guided decision-making (not validated) Questionnaire evaluating student scoring of algorithm (not validated)	Average score 3.7 (out of 5) regarding the value of the algorithm in facilitating clinical decision making	SQ 1&2	?	?
					1.1	?	
					1.2	?	
					1.3	?	
					1.4	?	
					1.5	?	

Study	Design	Participants	Measures / Analysis	Findings	MMAT		
Gilliland, S. (2014) Clinical Reasoning in First- and Third-Year Physical Therapist Students.	Qualitative	12: 6 1st year Physio students; 6 3rd year physio students	Verbal commentary whilst undertaking simulated patient assessment and treatment plan. Assessed against a framework Assessment against ICF domains Follow-up interview – thematic analysis	Hierarchy of sophistication yr1 vs yr3 Yr 3 students demonstrated better clinical reasoning Yr 1 students tended towards: trial and error, following protocol and rule in and out. Whereas Yr 3 students tended towards hypothetico-deductive and pattern recognition.	SQ 1&2	√	√
					1.1	√	
					1.2	√	
					1.3	√	
					1.4	?	
					1.5	√	
Gilliland, S., Flannery Wainwright, S. (2017) Patterns of Clinical Reasoning in Physical Therapist Students.	Qualitative case study	8 yr2 physiotherapy students with different placement exposure	Video and audio recording Thematic analysis of standardised patient encounter	Those demonstrating greater attention to physiotherapy education and empowerment of patients also demonstrated greater use of reflection in-action. Students demonstrated different approaches to the clinical encounter	SQ 1&2	√	√
					1.1	√	
					1.2	√	
					1.3	√	
					1.4	√	
					1.5	√	
Keiller, L., Hanekom, S.D., (2014) Strategies to increase clinical reasoning and critical thinking in Physiotherapy Education	Cross-sectional quant	38 particpants: 14 yr1; 24 yr2	Diagnostic Thinking Inventory, Self-assessment Clinical Reflections and Reasoning (SACRR) measure Pre and post intervention (use of concept maps)	The use of concept maps had no impact on the development of clinical reasoning and critical thinking. However, the use of Problem-based learning was of significance	SQ 1&2	√	√
					4.1	√	
					4.2	√	
					4.3	√	
					4.4	?	
					4.5	√	

Study	Design	Participants	Measures / Analysis	Findings	MMAT		
Sole, G., Skinner, M., Hale, L., Golding, C. (2019) *Developing a framework for teaching clinical reasoning skills to undergraduate physiotherapy students: A Delphi study*	Delphi Consensus study	41 academics/clinical educators/clinical supervisors	Online questionnaires – 3 rounds Round 1: free-text Round 2: Scoring (5 point Likert) Round 3 – Re-rating	Framework consisted of 8 elements to be articulated: CR definition Process Personal attributes Models of CR Components Patient-related factors Physio-related factors Other factors/sources	SQ 1&2	√	√
					4.1	√	
					4.2	√	
					4.3	?	
					4.4	√	
					4.5	√	

Appendix 3: MMAT Summary of the Simulation Literature at the Outset of the Study

<table>
<tr><th>Study</th><th>Design</th><th>Participants</th><th>Measures / Analysis</th><th>Findings</th><th colspan="3">MMAT</th></tr>
<tr><td rowspan="6">Alinier, G (2003)
Nursing students' and lecturers' perspectives of objective structured clinical examination incorporating simulation</td><td rowspan="6">Evaluation of introduction of simulated OSCEs to enhance skills-based learning</td><td rowspan="6">n= 86 students
n- 38 staff
3rd year physio students
n=61</td><td rowspan="6">Completion of questionnaire post voluntary attendance at simulated OSCE. Dichotomous questions.
Ascertained perceived benefit, impact on confidence and amount of sim needed</td><td rowspan="6">Descriptive stats
OSCEs deemed beneficial. Increased confidence reported
Positive association re: use of formative assessment, 'hands-on' nature</td><td>SQ 1&2</td><td>√</td><td>√</td></tr>
<tr><td>5.1</td><td colspan="2">?</td></tr>
<tr><td>5.2</td><td colspan="2">√</td></tr>
<tr><td>5.3</td><td colspan="2">?</td></tr>
<tr><td>5.4</td><td colspan="2">?</td></tr>
<tr><td>5.5</td><td colspan="2">√</td></tr>
<tr><td rowspan="6">Corrigan, R., Hardham, G. (2011)
Use of technology to enhance student self-evaluation and the value of feedback on teaching</td><td rowspan="6">Mixed methods evaluating usefulness of A-V feedback in developing self-awareness</td><td rowspan="6">voluntary attendance at practical exam – used video recording of exam</td><td rowspan="6">Questionnaire plus FG
Completion of questionnaire (post practical exam) and attendance at focus groups (post receipt of feedback)</td><td rowspan="6">Formative assessment seen as positive
Feedback very helpful and aids reflection
Does not replace actual clinical experience
Reported improved clinical reasoning at summative assessment but not substantiated</td><td>SQ 1&2</td><td>√</td><td>√</td></tr>
<tr><td>5.1</td><td colspan="2">?</td></tr>
<tr><td>5.2</td><td colspan="2">√</td></tr>
<tr><td>5.3</td><td colspan="2">?</td></tr>
<tr><td>5.4</td><td colspan="2">?</td></tr>
<tr><td>5.5</td><td colspan="2">√</td></tr>
<tr><td rowspan="6">Harder, N.B. (2010)
Use of Simulation in Teaching and Learning in Health Sciences: A Systematic Review</td><td rowspan="6">SR of quant studies assessing the outcome of hi-fidelity simulation</td><td rowspan="6">UG and PG
23 studies assessing either clinical skills and competence and/or self-assessment of clinical skills
Range of quasi-experimental and post intervention studies</td><td rowspan="6">Process of analysis not clear</td><td rowspan="6">Commented on lack of effect size and small studies
Simulation deemed to be effective in transferring knowledge to practice and improved self-assessment scores</td><td>SQ 1&2</td><td>√</td><td>√</td></tr>
<tr><td>SR.1</td><td colspan="2">√</td></tr>
<tr><td>SR.2</td><td colspan="2">√</td></tr>
<tr><td>SR.3</td><td colspan="2">?</td></tr>
<tr><td>SR.4</td><td colspan="2">?</td></tr>
<tr><td>SR.5</td><td colspan="2">√</td></tr>
</table>

Study	Design	Participants	Measures / Analysis	Findings	MMAT		
Heinrich, C., Pennington, R.R., Kuiper, R. (2012) Virtual Case Studies in the Classroom Improve Student Knowledge	Quasi-experimental	UG nursing students (ICU environment) n=56	MCQs to assess knowledge, critical thinking and decision-making Satisfaction and self-assessment using 5-point Likert scale	Increased knowledge Positive student experience Increased clinical competence	SQ 1&2	√	√
					3.1	√	
					3.2	√	
					3.3	√	
					3.4	?	
					3.5	√	
Howard, V.M.,Englert, N., Kameg, K., Perozzi, K. (2011) Integration of Simulation Across the Undergraduate Curriculum: Student and Faculty Perspectives	Mixed Methods	n= 151 Students (Questionnaire) n= 6 staff (Focus Group)	5-point likert scale used for student experience Unclear how student outcome was assessed Staff asked to identify improvements	Increased understanding Valuable learning experience Stimulated critical thinking Realistic Improved transference to practice Students were NOT less nervous than in actual clinical practice Simulation is NOT a substitute for actual clinical practice	SQ 1&2	√	√
					5.1	√	
					5.2	√	
					5.3	√	
					5.4	?	
					5.5	√	
Ladyshewsky, R., Baker, R., Jones, M., Nelson, L. (2000) Evaluating clinical performance in physical therapy with simulated patients	Feasibility study to establish validity of simulation as a standardised method of assessment	n=12 Student Physio n= 4 Postgraduate	Assessment of clinical competence based on an 88-point scoring system Student experience/rating of realism based on 5-point Likert scale	Effective method of standardising assessment Reliable and robust tool for assessment (alongside standardised patient) Improves consistency and reduces bias Effective in evaluating clinical performance	SQ 1&2	√	√
					3.1	√	
					3.2	√	
					3.3	√	
					3.4	?	
					3.5	?	

<table>
<tr><th>Study</th><th>Design</th><th>Participants</th><th>Measures / Analysis</th><th>Findings</th><th colspan="3">MMAT</th></tr>
<tr><td rowspan="6">Laschinger S., Medves J., Pulling C, McGraw R., Waytuck B., Harrison M.B., Gambeta K (2008)

Effectiveness of simulation on health profession students' knowledge, skills, confidence and satisfaction</td><td rowspan="6">Evidence synthesis of experimental /quasi-experimental studies</td><td rowspan="6">n=23 papers</td><td rowspan="6">Studies used a range of measure and meta-analysis impossible</td><td rowspan="6">Greater learner satisfaction
Increased student performance initially, but not maintained over time
Adjunct for clinical practice; not a replacement
Questionable transference of skills developed in simulation in clinical practice</td><td>SQ 1&2</td><td>√</td><td>√</td></tr>
<tr><td>SR.1</td><td colspan="2">?</td></tr>
<tr><td>SR.2</td><td colspan="2">√</td></tr>
<tr><td>SR.3</td><td colspan="2">?</td></tr>
<tr><td>SR.4</td><td colspan="2">?</td></tr>
<tr><td>SR.5</td><td colspan="2">√</td></tr>
<tr><td rowspan="6">Shoemaker M.J., Riemersma L., Perkins R., (2009)

Use of High Fidelity Human Simulation to Teach Physical Therapist Decision-Making Skills for the Intensive Care Setting</td><td rowspan="6">Case description of using simulation in the assessment, diagnosis and management of CVR patients,</td><td rowspan="6">CVR UG physios</td><td rowspan="6">Unclear – student ability assessed by faculty staff but not reported
Student emailed post-event and asked for feedback (14 responses)
Provided a narrative but no clear results</td><td rowspan="6">Improved confidence
Seen as useful by students</td><td>SQ 1&2</td><td>√</td><td>√</td></tr>
<tr><td>1.1</td><td colspan="2">√</td></tr>
<tr><td>1.2</td><td colspan="2">√</td></tr>
<tr><td>1.3</td><td colspan="2">√</td></tr>
<tr><td>1.4</td><td colspan="2">√</td></tr>
<tr><td>1.5</td><td colspan="2">√</td></tr>
<tr><td rowspan="6">Traynor M, Gallagher A., Martin L., Smyth S. (2010)
From novice to expert: using simulators to enhance practical skill</td><td rowspan="6">Mixed methods
Voluntary attendance – 3 scenarios
LOs identified</td><td rowspan="6">UG nursing students
n=156</td><td rowspan="6">Questionnaire re: the value of simulation 20 question 5-point likert scale
'qualitative data' open ended questions</td><td rowspan="6">Increased confidence
Realistic
Improved application of theory to practice
Safe</td><td>SQ 1&2</td><td>√</td><td>√</td></tr>
<tr><td>5.1</td><td colspan="2">?</td></tr>
<tr><td>5.2</td><td colspan="2">√</td></tr>
<tr><td>5.3</td><td colspan="2">?</td></tr>
<tr><td>5.4</td><td colspan="2">?</td></tr>
<tr><td>5.5</td><td colspan="2">√</td></tr>
</table>

Appendix 4: MMAT Summary of the Blended Learning Literature at the Outset of the Study

Study	**Design**	**Participants**	**Measures / Analysis**	**Findings**	**MMAT**		
Shah, I M; Walters, M R ; McKillop, J H, (2008) *Acute medicine teaching in an undergraduate medical curriculum: a blended learning approach*	Evaluation	99	Descriptive statistics based on Likert scale responses	Positive student experience Increased student confidence in the management of patients Seen as a supplement to f2f Not suitable for all topics – more challenging topics required f2f discussion	SQ 1&2 1.1 1.2 1.3 1.4 1.5	√ √ √ ? ? √	√
Moeller, S; Spitzer, K; Spreckelsen, C, (2010) *How to configure blended problem-based learning Results of a randomized trial:*	Randomised MM	237 (17 interview)	Questionnaire, self-test, self-assessment, structured interviews Non-para inferential testing of likert data No info re: analysis of data generated within interviews	No difference between synchronous and asynchronous learning in self-test Students felt asynchronous communication best facilitated learning Self-assessment increased most following the use of wiki case study discussions	SQ 1&2 5.1 5.2 5.3 5.4 5.5	√ ? √ √ ? ?	√
Rigby, L; Wilson, I; Baker, J; Walton, T; Price, O; Dunne, K; Keeley, P (2012) *The development and evaluation of a 'blended' enquiry based learning model for mental health nursing students: "making your experience count"*	Focus group	27	Thematic analysis	Students were able to apply an ethical model to practices Blended learning facilitates independent learning Improvement in in IT skills	SQ 1&2 1.1 1.2 1.3 1.4 1.5	√ √ √ ? √ √	√

Study	Design	Participants	Measures / Analysis	Findings	MMAT
Davidson, (2011) *A 3-year experience implementing blended TBL: Active instructional methods can shift student attitudes to learning*	Evaluation	3x100	Two-tailed t-test	Gradual increase in perceptions of blended (online) learning value over time	SQ 1&2 √ √ 1.1 √ 1.2 √ 1.3 ? 1.4 ? 1.5 √
Wakefield, A,B Carlisle, C; Hall, A G; Attree, M J (2008) *The expectations and experiences of blended learning approaches to patient safety education*	Pre and post interventio n Focus groups and individual interviews	12 (Int) 16 (FG) 18 staff (FG)	Content analysis	Poor engagement with flipped learning model IT access proved problematic for some	SQ 1&2 √ √ 1.1 √ 1.2 √ 1.3 ? 1.4 ? 1.5 ?
Croker, Karen ; Andersson, Holger ; Lush, David ; Prince, Rob ; Gomez, Stephen *Enhancing the student experience of laboratory practicals through digital video guides*	Post-test questionnai re	74	Descriptive statistics (dichotomous answers to questionnaire). Review of free text	Videos preferable to printed workbooks 50% used the resource as flipped learning Encouraged attendance in f2f Supported social learning	SQ 1&2 √ √ 1.1 √ 1.2 √ 1.3 ? 1.4 ? 1.5 √

Appendix 5: Copy of Initial SHU Ethics Application

An evaluation of the impact of embedding technology enhanced resources within the undergraduate cardio-respiratory Physiotherapy curriculum

Background:

Technology enhanced learning (TEL) is a broad term that incorporates many educational technologies such as on-line activities, wikis, e-portfolios (UCiSA, 2008, 2010), virtual/3D resources, simulation (DH, 2011) and the use of mobile devices and associated applications alongside conventional learning and teaching methods (Dror, 2008).

Developing technology enhanced learning within professional training programmes has been identified as a priority by the Higher Education Academy (HEA); *Learning 2.0 Harnessing Technology to Enhance Education*, the Joint Information Systems Committee (JISC); *Effective Practice in a Digital Age* and the Department of Health (DH); *Technology Enhanced Learning Framework*.

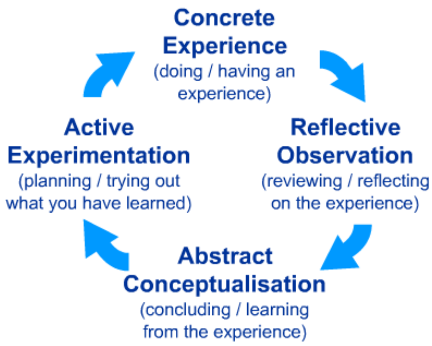
However, the use of TEL itself does not constitute an enhancement to the quality of teaching and learning (Beetham 2008). It is therefore important to consider the primary aim and proposed outcome of the programmes, employing sound pedagogical principles to identify where the use of technologies can act as an enabler and support the achievement of the desired outcome. The Department of Health (2011) set out a framework for the development of TEL in health and social care education with the aim of improving the safety and effectiveness of patient care. Strong links were made to the use of simulation to develop learners' skills prior to direct clinical experience.

In order to practice clinically as a Registered Physiotherapist, it is essential to be able to assess a situation, determine the nature and severity of the problem and call upon the required knowledge and experience to deal with the problem (HPC, 2007). Clinical reasoning is a term used to describe the process of requiring a background of scientific and technological research-based knowledge and a practical ability to discern the relevance of the knowledge, applying it to a particular clinical situation, forming clinical decisions or conclusions (Benner, Hughes, & Sutphen, 2008).

As underpinning knowledge is a pre-requisite for clinical reasoning, it is important to consider how educationalists facilitate and enable the acquisition, understanding and application of knowledge. Conceptual gateways have been identified as key concepts within a given subject, which, once acquired facilitate greater understanding and the transition to further knowledge (Meyer and Land, 2005). Threshold concepts have also been defined as key concepts that, if not understood, limit the potential to develop further knowledge and understanding (Meyer and Land, 2003 & 2005).

In addition to theoretical knowledge and understanding, Physiotherapy requires the development of practical skills. Kolb (1984) theorised that in order to learn practically, it is important experience a situation, reflect on the experience, learn from it and practice knew knowledge and skills, following 4 key stages:

Figure 1: Kolb's fours stages of experiential learning



Educational theory supporting the use of virtual and simulated environments in education often refers to constructivism, experiential learning, deliberative practice and the mental model (Ogle, 2002) due to the repeated performance of cognitive and/or psychomotor skills forming the development of clinical and technical ability. It can be argued, however, that whilst simulation aids the development of specific clinical skills (Issenberg et al, 2005) the ways in which some virtual resources are designed and utilised, facilitate only a concrete learning experience; thereby potentially limiting the student's ability to reflect on their learning experience, apply more broadly and develop abstract conceptualisation.

In order to further the learning experience within simulation and enable students to develop their learning outside of specific simulated environments, it is important to ensure that simulated activities are followed by immediate objective feedback and facilitated debrief in order to aid reflection and learning (Issenberg et al, 2005). However, replicating this model with large groups of undergraduate students and a high student to staff ratio proves challenging.

In developing the learning and teaching activities within the undergraduate cardiorespiratory physiotherapy programme at SHU, staff have considered both conceptual gateways and the theory of experiential learning. Student feedback has been sought on key areas within the programme that, when not fully understood, act as barriers in the transference of theoretical concepts to clinical practice. As a result, the delivery of high fidelity simulation, already embedded to provide practical experience in assessment and problem identification of cardio-respiratory patients, has been changed to provide a greater emphasis on reflection and learning through facilitated discussions; 3D virtual resources have been developed in order to provide visual representation for anatomical and physiological structures and processes; and additional technology enhanced resources have been developed with the aim of enabling students to gain a greater understanding of the range of interventions available for the management of patients with cardio-respiratory compromise.

In order to identify the impact of these new educational resources and ascertain whether they achieve the aim of improving the transference of knowledge and understanding to clinical reasoning and decision making, it is essential to instigate a process by which the outcome and impact can be measured.

Many studies to date have investigated either the experiences of students in relation to utilising e-learning/online resources (Bloom and Hough, 2003), or the acquisition of clinical/technical skills following the use of 3D virtual resources (Kneebone, 2005; Kilmon et al. 2010); however few have investigated the academic outcome or the development of clinical reasoning skills. As clinical reasoning is fundamental to the practice of a Physiotherapist, it is important to evaluate the impact of changes to the curriculum on clinical reasoning and perceived preparation for clinical practice.

The aim of this research is therefore to evaluate the impact of embedding a range of technology enhanced resources in the undergraduate cardio-respiratory physiotherapy curriculum on clinical reasoning skills and preparedness for clinical practice. In addition, student perceptions and experiences will be sought in relation to the range of learning and teaching resources utilised within the programme.

Objectives:

1. To assess the impact of technology enhanced resources compared to conventional resources on students' knowledge, understanding and application of key cardiorespiratory principles to assessment and treatment planning;
2. To evaluate the impact of technology enhanced resources compared to conventional resources on the student's self-assessment of knowledge, understanding and competence in the field of cardio-respiratory Physiotherapy assessment and treatment.
3. To gain insight into the perceptions of Physiotherapy students as to the value of learning and teaching resources (both conventional and technology enhanced) on knowledge acquisition, development of understanding/application of skills and preparedness for clinical practice.

Methodology:

DESIGN:

A quasi-experimental, mixed methodology design will be employed in order to assess each of the 3 main objectives. A crossover design has been identified as the most appropriate mechanism for delivering and enabling comparison of the different learning and teaching resources. For a given topic 3 different sessions will be designed utilising different resources/use of technology. After initial delivery and data collection the students will then crossover and receive the method of L&T not previously experienced. Knowledge and understanding will then be re-assessed. This will allow for comparison, whilst ensuring no student group is disadvantaged prior to the module’s summative assessment. In addition, the cross over design enables the Hawthorn effect to be minimised (Crookes and Davies 1998 p125), which is an important consideration when exploring student perceptions on how the different resources impacted on their knowledge, understanding and clinical reasoning. The washout period often referred to in clinical crossover trials cannot be addressed in this context and is acknowledged as a limitation. The carry-over implications have been considered and will be discussed in the data analysis section.

Focus group interviews will be utilised to gain insight into the learning experiences of students and their preparedness for clinical practice. Focus groups have been chosen over individual interviews as there is greater potential to expand on discussions and explore shared experiences (Kreuger and Casey, 2009) providing a richer pool of data (Kreuger 1998, Leung & Savithiri

2009). A semi-structured approach to the interview will be undertaken based on the identified topic guide (appendix 1).

SAMPLE:

A convenience sample of all 101 Level 5 students undertaking the Principles of Practice in Cardio-respiratory Physiotherapy module will be invited to participate in the project. Students are already allocated into groups within their cohort; this group allocation must be maintained to ensure clashes with other module teaching are avoided. It is therefore impossible to randomly allocate students to groups.

A power calculation has been undertaken to identify the minimum cohort size required to detect a statistically significant difference between the current cohort and the previous cohort's summative assessment task. In addition, a sample size calculation has been performed in order to identify the group size required to detect statistically significant changes between groups within the current cohort as part of the crossover assessment and re-assessment.

Table 1: Sample size calculations

	To compare current cohort's summative module mark against previous cohort	**To compare impact of different resources on learning across groups within current cohort (crossover)**
Minimally important difference	5 marks (per 100)	4 marks (per 100)
Level of significance (p- value)	0.05	0.05
Power	0.8	0.8
Effect size/estimated SD	0.4	0.5
Sample size needed	86 66	34

calculated using G*power (http://www.psycho.uni-duesseldorf.de/aap/projects/gpower/) and http://hedwig.mgh.harvard.edu/sample_size/js/js_crossover_quant.html

Students will be informed of the project at the outset of the academic year (appendix 2) and informed that they can opt out of the project at any time, receiving conventional teaching. Consent will be obtained from all students wishing to partake in the study (appendix 3).

METHOD:

Following participant consent and prior to commencement of teaching, baseline knowledge and understanding will be ascertained utilising a random selection of multiple-choice questions (MCQ).

As previously outlined, the current cohort is already divided into 3 teaching groups (n=33/34) so random allocation will not be undertaken; each group will instead be assigned to a different arm of the teaching resources:

> Group A will be assigned to conventional learning and teaching resources for the initial stages of content delivery

Group B will be assigned to conventional learning and teaching with additional mobile devices and access to online resources in class for the initial stages of content delivery

Group C will be assigned to the virtual/TEL resources for the stages of content delivery

At key points through the teaching repeat MCQs will be undertaken to identify knowledge acquisition and development of understanding. After completion of the initial stages of content delivery student will also be asked to complete a self-assessment questionnaire (figure 2).

During weeks 24-26 each group will receive the resources in the format they have not yet received to ensure no student is disadvantaged. The impact of the crossover teaching will then be assessed by utilising a random selection of MCQs.

Figure 2: Outline schedule of delivery and data collection for crossover and self-assessment aspects of project

Intro to module and research project (week7)

Baseline MCQ

Core teaching - anatomy, physiology and assessment (weeks 8-10)

Group a - conventional teaching and resources	Group b - conventional with access to online resources	Group c - virtual resources

Assessment of core learning (week 11)

repeat MCQ 1

Further teaching - problem identification, treatment/intervention selection and justification (weeks 13-14)

Group a - conventional teaching and resources	Group b - conventional with access to online resources	Group c - technology enhanced resources

Assessment of further learning (week 14)

rpt MCQ 2	self assessment of cardiorespiratory assessment and treatment planning

Crossover teaching (weeks 24-26)

Group a - virtual and technology enhanced /online resources	Group b - technology enhanced resources	Group c - conventional with access to online resources

Assessment of further learning (week 26)

repeat MCQ 3	repeat self assessment of cardiorespiratory assessment and treatment planning

Following completion of the module, students will undertake 2 separate clinical placements. Although students are not guaranteed a placement within the speciality of cardio-respiratory Physiotherapy, opportunities often arise to assess and treat cardiorespiratory patients on other speciality placements. On return from placement any student who has experienced a cardio-respiratory patient on placement will be invited to participate in focus group interviews to discuss their preparedness for assessing and treating cardio-respiratory patients. Perspectives on the different learning and teaching resources and their value in developing understanding and clinical reasoning skills within the field of cardio-respiratory Physiotherapy will also be explored. It is anticipated that these focus groups will take place during weeks 43-46.

Each focus group will consist of a maximum of 8 students with additional focus groups taking place until data saturation has occurred. There is variation in the literature regarding appropriate sample size for a focus group (Kreuger & Casey 2009, Kitzinger 2009). Issues taken into consideration when determining focus group size include that it is sufficient to generate and maintain stimulating dialogue and that the group dynamic is such that all members have opportunity to contribute.

DATA COLLECTION:

Data Set a)

MCQ's will be utilised to assess baseline knowledge and again after each delivery of L&T activities. The MCQs are currently utilised within the programme as formative assessments, therefore the introduction of these MCQs are not adding to the assessment burden of the students. MCQs are an established method of assessing knowledge, although it has been argued that testing knowledge alone in the form of MCQs does not guarantee professional competence (McCoubrie 2004). However Glasner (1984) and Downing (2002) have discussed how appropriate design enables the assessment of knowledge including interpretation, synthesis and application rather than merely recall of facts.

Students will be asked to answer 30 MCQs at each stage of the data collection, randomly selected from a pool of 150 questions.

Data Set b)

A validated self-assessment questionnaire utilising a likert scale to rate perceived level of confidence in assessment, problem identification and treatment planning will be used to collate information from each student after 1st delivery and again after cross over delivery to assess the perceived impact of the different learning and teaching resources/activities.

Self-reporting has been identified as an important process in healthcare, providing access to information that only the individual knows (Laver fawcett, 2009 p 49); including both cognitive processes and subjective information (Barlow and Hersen 1984, p 124). It can be argued that this is transferable to the education sector as this enables academics to prioritise further learning and teaching foci.

The self-assessment of competence measure has been specifically designed and validated to aid UG Physiotherapy students identify both areas of strength and ongoing learning needs in preparation for clinical practice, and hence has been deemed an appropriate measure in enabling objective 2) to be assessed.

Assessor blinding will be employed for the data collection of data sets a) and b) utilising a range of online tools (Grade Centre within Blackboard and pebblepad). The data sets will be downloaded in a format that enables paired data to be analysed but with no participant identifiable information.

Data Set c)

Focus group interviews will be utilised to explore student experiences of different learning and teaching resources and activities throughout the module.

A topic guide (Appendix 1) will be developed in order to support the process and enable a full exploration of the perceived value of the different learning and teaching resources and impact on knowledge acquisition, understanding and preparedness for clinical practice.

Data Set d)

Results from the module's practical summative assessment task will be collected and compared to the previous cohort. The previous cohort will be acting as a control as they received conventional teaching alone and the same summative assessment task. The task assesses the students' ability to assess and apply clinical reasoning skills to an unseen clinical scenario.

DATA ANALYSIS:

Data set a)

Inferential statistical analysis using either a paired t-test analysis or Wilcoxon (depending upon data distribution) will identify the acquisition of knowledge from baseline. This will be repeated after the cross-over process to identify further gains in knowledge.

Between group analysis across scores from groups A, B and C at each stage will be for formed, utilising either an ANOVA or Kruskal-Wallis test.

Washout periods cannot be addressed in this context due to the research assessing the acquisition of knowledge.

The magnitude of the increase in knowledge and understanding will be assessed by undertaking a within group analysis using a paired t-test or Wilcoxon test. This will enable the relative impact of the different resources to be established

Data set b)

Between group analysis of self-assessment scores will be performed to ascertain if the learning and teaching activities impact on self-perception scores utilising either an ANOVA or Kruskal-Wallis test.

Within group analysis using a paired t-test or Wilcoxon test will be utilised comparing data sets after crossover teaching

Data set c)

Audio and video data from focus group interviews will be recorded to enable verbatim transcription and the identification of facial expressions and additional non-verbal communication. Thematic analysis of the transcripts will be undertaken to identify the nature of responses, define concepts and find associations between themes (Ritchie & Lewis (2003) p 200-2, Pope & Mays (2006) and Kreuger & Casey (2009)).

Data set d)

Between group analysis of summative assessment results will be performed to ascertain if the TEL impacted on the outcome of the summative assessment, utilising either an un-related t-test or Mann-Whitney.

One year's data Paired data: Repeated measures one-way ANOVA / freedman test (non parametric) and Dunns (non parametric) / Tukey (parametric) post test to compare the groups. For each cohort

Comparing the different cohorts– un paired t-test this demonstrates the difference in academic ability for the 2 years

ETHICAL CONSIDERATIONS:

In order to ensure no student is disadvantaged, a cross-over design was chosen to guarantee each student receives all versions of the learning and teaching resources. Although there are acknowledged limitations with this design, it was deemed to be most appropriate as the module is a compulsory module within the programme and hence the summative mark awarded contributes towards the overall degree classification of the student.

Students will be informed of the research project at the outset of the module and given the opportunity to opt-out. Students who opt out will receive conventional teaching, but will not be expected to undertake the data collection exercises. The self-assessment tool will be made available to those students who have opted out as an optional aid for the identification of on-going learning needs.

The MCQs and self-assessment tool are already utilised as formative assessment tasks with the module; by using these more formally as a data collection tool no additional burden is placed on the student.

Students will be informed that no quantitative data analysis will take place until after the module is complete; assessor blinding will also ensure that the student scores remain anonymous and no tutor is aware of individual student outcome from the MCQs or self-assessment tool.

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Copy of Initial SHU Ethics Application Appendix 1 - topic guide (tbc)

Outline

a) set and agree ground rules
   - consent - free to withdraw at any time: comments and questionnaire will be discounted
   - confidential
   - safe and honest - any all comments welcomed
   - all opinions equally respected
   - all participants encouraged to interact and feedback

b) discuss focus group questions

c) thank participants for their contributions and close meeting

Suggested Questions for focus group meeting

1. Tell me about the types of cardio-respiratory patients you have seen on placement
   - what settings have you encountered them in?
   - were you involved in their assessment and treatment?
   - how did you find the experience? was it what you expected?

2. Did you feel the PCRP module prepared you for this?
   - in what way?

3. What core cardio-respiratory knowledge do you think is essential before experiencing cardio-respiratory patients in clinical practice?

4. Going back to the beginning of the module what are your thoughts on the core teaching about anatomy, physiology and assessment?
   - what are the key topics you found easiest to understand?
   - what are the topics you found hardest to understand?
     i. were there any resources or activities that made these topics easier to understand?

5. Thinking about the teaching on problem identification, treatment/intervention selection and justification
   - what did you find easiest to understand?
   - what did you find hardest to understand?
     i. were there any resources or activities that made these topics easier to understand?
   - do you think these sessions helped develop your clinical reasoning?
   - could you apply/transfer what was covered in class into clinical placement?

6. Do you feel the use of technology both within the sessions and the additional resources provided have impacted on your learning?
   - in what way?

Appendix 6: Participant Information Sheet

Sheffield Hallam University

Participant information sheet

Study title:	An evaluation of the impact of embedding technology enhanced resources within the undergraduate cardio-respiratory Physiotherapy curriculum
Chief investigator	Mel Lindley
Telephone number	01142252483

Study Sponsor: Sheffield Hallam University

You are invited to take part in a research study. Before you decide it is important that you understand why the research is being done and what it would involve for you. Talk to others about the study if you wish. Ask if there is anything that is not clear.

The aim of this study is to implement and evaluate the impact of different teaching resources on your learning and development of clinical reasoning skills in cardio-respiratory Physiotherapy.

Different teaching resources have been developed for the Level 5 cardio-respiratory module for the 12/13 academic year. You are therefore invited to experience these different resources and assist the team in identifying whether this has impacted on your learning.

You will be given a copy of this information sheet to keep

Participant name:

1. What is the purpose of this study?

The purpose of this study is to implement and evaluate the impact of different teaching resources on your learning and development of clinical reasoning skills in cardio-respiratory Physiotherapy.

2. Why have I been invited?

You have been invited to take part as you are about to undertake the Level 5 Principles and Practice in Cardio-Respiratory Physiotherapy (PCRP) module.

3. Do I have to take part?

Your decision to take part in this study is entirely voluntary. You may refuse to participate, or you can withdraw from the study at any time. Your refusal to participate or wish to withdraw would not influence your learning on the module in any way. Anyone wishing not to take part or withdrawing from the study will receive the traditional teaching for the module.

4. What will happen to me if I take part?

If you participate in the study you will receive technology enhanced learning and teaching resources in addition to the traditional teaching for the module. You will also be asked to complete a series of multiple choice questions to allow us to identify the impact of these new resources on your knowledge and understanding.

5. Expenses and payments

You will not be paid for taking part in this study. There should be no additional expenses incurred as a result of taking part in this study

6. What will I have to do?

If you agree to take part in the study you will attend the module teaching as normal but we will ask you to undertake a series of MCQs at specific times (see diagram on next page). The results of these MCQs will not be made available to the module team.

You may also be asked to be part of a focus group to discuss your opinions of the different teaching resource. This would take place once you have completed the module and will depend on your clinical placement experiences.

7. What are the alternatives?

If you decide not to take part, you will receive the traditional teaching for the module and you will not be asked to undertake the MCQs or the focus group.

8. What are the possible disadvantages and risks of taking part?

No disadvantages or risks have been identified in taking part in this study, however, you may feel that undertaking the additional MCQs or attending a focus group discussion causes an inconvenience.

9. What are the possible benefits of taking part?

You may find that by taking part in this study and using the additional technology enhanced resources, your learning for the module is improved.

10. What if there is a problem or I want to complain?

If you have any queries or questions please contact: Mel Lindley

Principal investigator: M.Lindley@shu.ac.uk 01142252483

Sheffield Hallam University, Faculty of Health and Wellbeing

Alternatively, you can contact my supervisor: Dr Neil McKay: N.Mckay@shu.ac.uk

01142252760

If you would rather contact an independent person, you can contact Peter Allmark (Chair Faculty Research Ethics Committee) p.allmark@shu.ac.uk; 0114 225 5727

11. Will my taking part in this study be kept confidential?

Yes. The results from the MCQ tests will be downloaded by an independent technician who will anonymise the data before it is analysed. All MCQ results will be completely confidential and will not be seen by any of the teaching team.

If you participate in the focus group after the module, the interview will be recorded and then written up word for word. The researcher will check that the recording and the written transcript are the same. The recording will then be erased. The transcript will be kept on a password-protected computer.

Identifying details will be taken out of any final report and any publication so people reading these will not be able to identify you. The written transcripts will have all links to you removed at the end of the study and will then be kept for as long as they might be useful in future research.

12. What will happen to the results of the research study?

The results of this study will be shared with students, it might go for publication or onto a public database.

13. Who is sponsoring the study?

The sponsor of the study has the duty to ensure that it runs properly and that it is insured. In this study, the sponsor is Sheffield Hallam University.

14. Who has reviewed this study?

All research based at Sheffield Hallam University is looked at by a group of people called a Research Ethics Committee. This Committee is run by Sheffield Hallam University but its members are not connected to the research they examine. The Research Ethics Committee has reviewed this study and given a favourable opinion.

15. Further information and contact

If you have any queries or questions please contact: Mel Lindley, Principal investigator: M.Lindley@shu.ac.uk Tel: 01142252483

Appendix 7: Blank Participant Consent Form

Sheffield Hallam University

Participant consent form

Study title:	An evaluation of the impact of embedding technology enhanced resources within the undergraduate cardio-respiratory Physiotherapy curriculum
Chief investigator	Mel Lindley
Telephone number	01142252483

Participant name	

	Please read the following statements and put your initials in the box to show that you have read and understood them and that you agree with them	Please initial each box
1	I confirm that I have read and understood the information sheet dated **xxxxxxxxx** for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2	I understand that my involvement in this study is voluntary and that I am free to withdraw at any time, without give any reason and without my educational or legal rights being affected.	
3	I understand that relevant sections of my data collected during the study may be looked at by responsible individuals from the Sponsor, the Research Ethics Committee and from Sheffield Hallam University, where it is relevant to this research. I give permission for these individuals to have access to my records.	
4	I agree to take part in this study	

Participant consent form

To be filled in by the participant

I agree to take part in the above study

Your name	Date	Signature

To be filled in by the person obtaining consent

I confirm that I have explained the nature, purposes and possible effects of this research study to the person whose name is printed above.

Name of investigator	Date	Signature

Filing instructions

1 copy to the participant
1 original in the Project or Site file

Appendix 8: Copy of SHU Ethics Approval

Research proposal review form: Sept 2010

Faculty of Health and Wellbeing
Faculty Research Ethics Committee
Health and Social Care Division

Research Proposal Review Form

Review Summary

Name of researcher: LINDLEY M

Project title: An evaluation of the impact of embedding technology enhanced resources within the undergraduate cardio-respiratory Physiotherapy curriculum

Name of supervisor: BURTON M, GRANT G, SMITH L

Code for Decision: Satisfactory Review Achieved
~~Satisfactory Review with some advice~~
~~Unsatisfactory Review – needs amendments~~

Signature of Reviewer: Allmark P/ Alex McClimens

Date: 14.09.2012

Feedback : This is a low-risk project that is well formulated and supported by a strong team.

Site/Project files
An up-to-date project or site file must be maintained for the duration of the project and afterwards. The file might be inspected at any time.

Mental Capacity
Special procedures now apply to any research that involves adults without mental capacity to consent to that research. This applies both to the NHS and to Social Care Research. Please contact Peter Allmark to discuss if that applies to this study.

1

Research proposal review form: Sept 2010

Checklist for Independent Scientific Review

General	**Yes**	**No**	**N/A**
The aims of the project are clearly stated	✓		
The project is original in concept with evidence to support the project's originality in the literature review	✓		
The project is useful and relevant to clinical practice, policy making or workforce planning	✓		
The project is feasible in the time available	✓		
Service users have been involved in the development of the proposal where possible			✓
A completed project safety plan is included with the proposal	✓		
A completed registration form is included	✓		

Method / design / analysis	**Yes**	**No**	**N/A**
The design is appropriate for the identified aims	✓		
A clear rationale for the use of systematic literature review is included	✓		
The review procedure chosen is appropriate			✓
The sampling strategy chosen is appropriate for the identified aims.			✓
A power calculation has been undertaken if appropriate.			✓
Methods to be used to identify, approach and recruit participants have been included	✓		
Trustworthiness and rigour of data collection are considered	✓		
Measurement issues are addressed in relation to clinically appropriate measuring tools.			✓
The validity and reliability of the outcomes measures chosen have been considered (this included questionnaires to be used)			✓
An appropriate plan of analysis is included with reflection on the implications of the sample size.	✓		
The project attempts to look at individual data as well as aggregated data			✓
There is a logical and feasible research time plan with clearly delineated milestones.	✓		
Itemised costings are included			✓
Issues concerning racial and cultural diversity have been considered	✓		
Participant information and consent forms have been included			✓

Have issues around controlling bias been considered	✓		
Has a statistical opinion been included if appropriate			✓
Have indemnity issues been considered (FIN 12 included if appropriate.)			✓
Have funding arrangements been made clear (ENT 1 enclosed if appropriate)			✓
Have methods for the dissemination of results been considered.	✓		
Have intellectual property arrangements been considered (if appropriate)			✓

2

Research proposal review form: Sept 2010

Checklist for Ethical Approval

SAFETY ISSUES - Refer to the project safety plan as well as the protocol.	**Yes**	**No**
Is there is any potential for physical or psychological harm or distress to research participants?		✓
If Yes: a) Are adequate mechanisms in place to minimise the risk and to tackle any harm or distress that occurs?		
b) Is the potential risk of harm balanced by potential benefit to participants?		
Is there is any potential for physical or psychological harm or distress to the researcher(s)?		✓
If Yes: a) Are adequate mechanisms in place to minimise the risk and to tackle any harm or distress that occurs?		
Are any of the participants likely to belong to a so-called vulnerable group, for example, children, people with mental health problems or with learning disability, people in a dependent relationship to the researcher(s)?*		✓
Is there a named Project Safety Supervisor?	✓	

* See note on Mental Capacity on the front sheet.

RIGHTS ISSUES	**Yes**	**No**
Are issues of confidentiality, privacy and data protection adequately covered in relation to:	✓	
a) The recruitment of participants?	✓	
b) The protection of the privacy of participants?	✓	
c) The protection and storage of confidential information generated by the study?	✓	
Will informed consent be obtained from the participants?	✓	
Is there a satisfactory:		
a) Participant information sheet?		NA
b) Participant consent form? [Note: a consent form is not required for questionnaire studies.]		✓
Does the research involve the removal of any human tissue from participants? Human tissue is, in effect, any sample taken from the human body apart from nails and hair.		✓
Does this proposal adequately address any issues of ethnic diversity or other diversity issues?	✓	
Do you believe this proposal needs specialist ethics review?		✓

Appendix 9: Copy of Independent Assessor(s) Proforma for Applications for Confirmation of PhD (Form RF2P)

Sheffield Hallam University *Updated April 2015*	**Independent Assessor(s) Proforma for Applications for Confirmation of PhD (Form RF2P)**
Name of candidate	**Mel Lindley**
Name of independent assessor (s)	**Graham Holden Nicola Clibbens**
Assessment criteria to be considered	**Please complete the sections below**
RF1-related issues • *Are Ethics and H&S issues being addressed appropriately?* • *Has the candidate satisfactorily completed the programme of related studies?*	Ethical and health and safety issues have been adhered to throughout the study. No issues regarding the programme of related studies.
The Report	

Literature Review, methodology and progress. • *Has the candidate demonstrated an understanding of the current state of knowledge in the field as evidenced by relevant literature?* • *Has the candidate demonstrated mastery of the methodologies appropriate to his/her research enquiry?* • *Has the candidate settled on a methodology or is he/she been keeping their options open?* • *Is there evidence that progress has been made and some results obtained?* • *Is the quality of the academic/technical writing used in the candidate's report of an appropriate standard to complete the doctoral project?*	Mel has conducted appropriate reviews of policy and research and these have been used effectively to inform the design and conduct of the study. The study has been designed to reflect relevant theories around the role of technology in enhancing learning and its impact on learning gain. The methodology used is appropriate to the research enquiry. There is however a need to outline the philosophical underpinning of the study with greater clarity in order to effectively articulate the operationalising of the study methods. The data collection for the study is complete in the view of the assessors. There is more work required to deepen the analysis of the data already collected particularly around the qualitative study and the mixed method synthesis.
Future work and project planning	The report presented a number of suggested further areas of primary inquiry; the assessors feel that these should be presented as recommendations for future 'post-doc' study. This will enable the remaining doctoral work to focus on depth of discussion and analysis of the

• *Is there clarity over the intended further work? Does the proposed time-line appear practicable?* • *Is there a clear indication of the original contribution to knowledge that will emerge from this project to make it a suitable basis for work at doctoral standard?*	data collected. This will also ensure that there is a clear focus on the key objectives of the thesis. The viva uncovered a clearer sense of what constitutes original contribution in this study; Mel should consider with her supervisory team both educational and methodological contributions to the body of knowledge.
The Oral Assessment	
Presentation and defence • *Has the candidate demonstrated an ability to defend his/her work i.e. to respond confidently to critical questioning?* • *Are the candidate's language skills strong enough to a) complete a thesis and b) undertake a viva successfully in English?* • *Are there other presentation-skills issues that should be addressed (for either the report or the oral assessment)?*	Mel demonstrated an articulate and considered approach to her study. Through discussion she was able to confidently assert her position whilst also considering where her work could be advanced in the remaining doctoral study time-line. Both assessors are confident that Mel is operating at doctoral level and needs to spend the remaining time deepening her thinking around the study she has conducted in readiness for submission and final oral examination.

Other general comments which can be passed on to the candidate and supervisors for reference **Date………30/06/2015……..** **Name of assessor(s)…Nicola Clibbens and Graham Holden…** **Signature(s)…Nicola Clibbens** **Graham Holden**	Our recommendations are: • There is no need for further data collection. The suggested areas of further enquiry should be presented as recommendations for further study (post doc). • There needs to be a more clearly articulated link between the philosophical basis of the study and the methods applied. • There are areas of the study where the analysis of the existing data can be deepened; Mel has suggested some further quantitative analysis from the experimental arm of the study. We also suggest further analysis of the focus group data with particular emphasis on the analysis of video data and approaching the data as a 'group' rather than as individual data. • There is a need to justify and explain more clearly the mixed method synthesis. Mel was able to articulate where the two methods had converged to inform her findings but this has not been fully articulated as a methodological process. • It may be helpful to consider presenting a reflective account of 'Mel' as researcher and the journey taken to the findings in this study. This may help to clarify some of the blurred lines between current and previous roles in physio education and TEL as well as between PhD study and previous project work undertaken.

The Decision	**Recommendation of the Assessment Panel (for first assessments)**
	Name of Pg Research Tutor……Maria Burton…………………………………….. R M Burton **Signature** **Name of Assessor/s: Nicola Clibbens, Graham Holden** **Signature/s…Nicola Clibbens Graham Holden** **Date of Panel Decision……30/06/2015** **We have considered all aspects of the candidate's ability and performance against the assessment criteria on this form as detailed by the assessor(s). We recommend to the Research Degrees Sub-committee as follows:**
Option A should be chosen if the **candidate has passed and no further work is required**. Comments may be provided for the candidate to consider.	**a) Approve confirmation of PhD registration without further work ✓**
Option B should be chosen if the **candidate has passed but is required to clarify some of the points raised by the assessor(s).** This means that in order to progress satisfactorily, ***<u>the issues</u>***	**b) Approve confirmation of PhD registration subject to the following conditions: ☐** **(please state conditions below which must be addressed now)**

raised must be addressed now or the development of the project will be impeded. The conditions must be clearly specified. **Full-time students will have 1 month to respond to the points raised and part-time students will have 2 months.**	……….. ……….. ……….. ………..
Option C should be chosen if the **candidate has failed and is being referred for a second attempt**. The conditions must be clearly specified. **Full-time students will have 3 months to re-present their application and part-time students will have 6 months.**	**c) Refer the application for confirmation of PhD registration back to the candidate** ☐ **and supervisory team for further work and/or assessment as follows (please write detailed comments** **overleaf if necessary):**

Appendix 10: Focus Group Topic Guide

Outline

d) set and agree ground rules
   - consent - free to withdraw at any time: comments will be discounted
   - confidential
   - safe and honest - any all comments welcomed
   - all opinions equally respected
   - all participants encouraged to interact and feedback

e) ice breaker activity

f) discuss focus group questions

g) thank participants for their contributions and close meeting

Ice breaker activity

Whiteboard activity asking students to identify what they remembered from the module and whether it was positive or negative

Suggested Questions for focus group meeting

7. Tell me about the types of cardio-respiratory patients you have seen on placement
   - what settings have you encountered them in?
   - were you involved in their assessment and treatment?
   - how did you find the experience? was it what you expected?
8. Did you feel the PCRP module prepared you for this?
   - in what way?
9. What core cardio-respiratory knowledge do you think is essential before experiencing cardio-respiratory patients in clinical practice?
10. Going back to the beginning of the module what are your thoughts on the core teaching about anatomy, physiology and patient assessment?
    - what are the key topics you found easiest to understand?
    - what are the topics you found hardest to understand?
      i. were there any resources or activities that made these topics easier to understand?
11. Thinking about the teaching on problem identification, treatment/intervention selection and justification
    - what did you find easiest to understand?
    - what did you find hardest to understand?
      i. were there any resources or activities that made these topics easier to understand?
    - do you think these sessions helped develop your clinical reasoning?
    - could you apply/transfer what was covered in class into clinical placement?
12. Do you feel the use of technology both within the sessions and the additional resources provided have impacted on your learning?
    in what way?

Appendix 11: MCQ Pool of Questions

Type	**Anatomy and mechanics**	Answer 1	Outcome	Answer 2	Outcome	Answer 3	Outcome	Answer 4	Outcome
MC	What is the role of the internal intercostal muscles?	to aid active expiration	correct	to aid active inspiration	incorrect	to aid passive inspiration	incorrect	to aid active inspiration and expiration	incorrect
MA	Which of the following muscles are termed 'accessory muscles' in relation to increased work of breathing?	sternocleidomastoid	correct	Scalenes	correct	serratus posterior	correct	diaphragm	incorrect
MC	What is the primary function of the diaphragm?	the major muscle of inspiration	correct	the major muscle of expiration	incorrect	as an accessory muscle	incorrect	to aid coughing	incorrect
MC	What is the role of abdominal muscles in relaxed breathing?	to maintain intra-abdominal pressure	correct	to aid active inspiration	incorrect	to aid passive inspiration	incorrect	to aid coughing	incorrect
MC	What is the role of the abdominal muscles during active exhalation?	to increase the speed of expiration	correct	to increase inspiratory volume	incorrect	to aid passive inspiration	incorrect	to increase the speed of inspiration	incorrect
MC	What is the anterior attachment of ribs 2-6?	hyaline costal cartilages	correct	sternum	incorrect	corresponding vertebral body	incorrect	parietal pleura	incorrect
MC	What are the posterior attachment of ribs 2-12?	upper border of the body of its own vertebra and lower border of the vertebra above	correct	lower border of the body of its own vertebra and upper border of the vertebra above	incorrect	upper border of the body of its own vertebra and upper border of the vertebra above	incorrect	lower border of the body of its own vertebra and upper border of the vertebra above	incorrect
MC	What is the function of the c-shaped cartilaginous rings that line the anterior portion of the trachea?	maintain structure and protection	correct	produce mucous	incorrect	to aid gas exchange	incorrect	to aid mucociliary function	incorrect
MC	What do goblet cells produce	neutral and acidic glycoproteins	correct	surfactant	incorrect	lipids	incorrect	phosphates	incorrect
MC	What is the function of the cilia?	propel mucus up towards the pharynx	correct	propel mucus to the alveoli	incorrect	to produce mucus	incorrect	maintains surface tension within the alveoli	incorrect
MC	Which of the following do NOT affect cilia function?	respiratory rate	correct	smoking	incorrect	humidity	incorrect	anaesthesia	incorrect
MC	Select one of the following that best describes the type of epithelium that forms the mucosal lining of the trachea	cilliated columnar epithelial cells	correct	type I epithelial cells	incorrect	type II epitheilia cells	incorrect	endothelial cells	incorrect

MC	Which are the cells that secrete surfactant?	type II epithelial cells	correct	type I epithelial cells	incorrect	goblet cells	incorrect	endothelial cells	incorrect
MC	Select one from the following to complete the sentence. The cells that make up the structure of the alveolus and enable gas exchange are:	type I epithelial cells	correct	type II epithelial cells	incorrect	goblet cells	incorrect	endothelial cells	incorrect
MC	Complete the following sentence: When the external intercostal muscles contract	the rib cage moves outwards in a bucket handle motion	correct	the rib cage moves outwards in a pump handle motion	incorrect	the rib cage moves upwards in a pump handle motion	incorrect	the rib cage moves inwards in a bucket handle motion	incorrect
MC	The function of the left ventricle is?	to pump oxygenated blood to the body	correct	to pump de-oxygenated blood to the body	incorrect	to pump oxygenated blood to the lungs	incorrect	to pump deoxygenated blood to the lungs	incorrect
MC	The blood vessel the transports blood FROM the right ventricle is the:	pulmonary vein	correct	pulmonary artery	incorrect	vena cava	incorrect	aorta	incorrect
MC	The vessels the attach to the aortic notch are:	carotid, subclavian and coronary arteries	correct	coronary, pulmonary and carotid arteries	incorrect	jugular, carotid and subclavian arteries	incorrect	carotid, subclavian and coronary veins	incorrect
MC	The valve between the left atrium and the left ventricle is	mitral valve	correct	tricuspid valve	incorrect	pulmonary valve	incorrect	aortic valve	incorrect
MC	The valve between the right atrium and the right ventricle is	tricuspid valve	correct	mitral valve	incorrect	pulmonary valve	incorrect	aortic valve	incorrect
MC	The vessel returning deoxygenated blood to the right atrium is the:	vena cava	correct	pulmonary artery	incorrect	pulmonary vein	incorrect	aorta	incorrect
MC	What BP a measure of?	the pressure exerted by the blood on the arterial vessel walls	correct	the pressure exerted by the blood in the venous system	incorrect	the force of contraction of the left ventricle	incorrect	the force of contraction of the right ventricle	incorrect
MC	The movement of the ribs during respiration is described as:	bucket handle	correct	pump handle	incorrect	rotation	incorrect	extension	incorrect
MC	The movement of the sternum during respiration is described as:	pump handle	correct	bucket handle	incorrect	extension	incorrect	rotation	incorrect
MC	How many lobes are there in the right lung?	3	correct	2	incorrect	4	incorrect	10	incorrect
MC	How many lobes are there in the left lung?	2	correct	3	incorrect	7	incorrect	9	incorrect
MC	How many broncho-pulmonary segments are there in the right lower lobe?	5	correct	4	incorrect	3	incorrect	6	incorrect

MC	How many broncho pulmonary segments are there in the left lung?	9	correct	10	incorrect	7	incorrect	3	incorrect
MA	Tick all that are appropriate: An artery wall is made up of	elastic tissue	correct	smooth muscle	correct	fibrous tissue	correct	valves	incorrect
MA	Tick all that are appropriate: A vein is made up of	elastic tissue	correct	smooth muscle	correct	fibrous tissue	correct	valves	correct
MC	What is the structural difference between a bronchi and a bronchiole	bronchioles do not contain cartilage	correct	bronchioles are larger	incorrect	bronchioles don't contain smooth muscle	incorrect	bronchioles don't have epithelial cells	incorrect
	Physiology:								
MC	The respiratory centre in the brainstem is commonly referred to as the	central pattern generator	correct	breathing pattern generator	incorrect	respiratory pattern generator	incorrect	inspiratory pattern generator	incorrect
MC	The amount of air passing in and out of the lungs during quiet breathing is called	tidal volume	correct	inspiratory volume	incorrect	inspiratory capacity	incorrect	total lung volume	incorrect
MC	Anatomical dead space refers to:	the areas within the respiratory tract where gaseous exchange cannot occur	correct	the areas within the respiratory tract where gaseous exchange occurs	incorrect	blockage within the respiratory tract	incorrect	air trapped within the respiratory tract	incorrect
MC	Physiological dead space in the alveoli refers to:	the air within the alveoli that does not take part in gas exchange	correct	the air within the alveoli that does take part in gas exchange	incorrect	blockage within the alveoli	incorrect	air trapped in the bronchioles	incorrect
MC	What does FRC stand for?	functional residual capacity	correct	functional respiratory capacity	incorrect	forced respiratory capacity	incorrect	forced reserve capacity	incorrect
MC	The centres in the brain that control breathing are	medulla and pons	correct	cerebral cortex and foramen magnum	incorrect	spinal cord and cerebellum	incorrect	cerebral cortex and cerebellum	incorrect
MC	In a normal healthy adult, the pressure within the alveoli at the end of expiration is:	equal to atmospheric pressure	correct	lower than atmospheric pressure	incorrect	higher than atmospheric pressure	incorrect		incorrect
MC	In a normal healthy adult, the pressure within the alveoli and the pleura at the beginning of inspiration is	lower than atmospheric pressure	correct	equal to atmospheric pressure	incorrect	higher than atmospheric pressure	incorrect		incorrect
MC	Vital capacity is equal to	the maximum amount of air a person can expel from the lungs after a maximum inhalation	correct	the maximum amount of air that a person can inhale	incorrect	the maximum amount of air that a person can exhale	incorrect	the amount of air left in the lungs after a normal exhalation	incorrect

MC	Lung closing volume is:	the volume of gas in the lungs that is no longer sufficient to prevent airway closure	correct	the volume of gas in the lungs that stops airway closure	incorrect	the volume of gas in the lungs that is needed to overcome airway closure	incorrect	the volume of gas remianing in the lungs after a normal breath out	incorrect
MA	Factors affecting BP include (tick all that apply):	amount of circulating blood volume	correct	contractility of the heart	correct	vascular resistance	correct	efficacy/patency of cardiac valves	correct
MC	Residual volume is:	the amount of gas remaining in the lungs after a maximal breath out	correct	the amount of gas remaining in the lungs after a normal/tidal breath out	incorrect	the volume in the lungs still available after a normal/tidal breath in	incorrect	the volume of gas in the lungs whereby airway closure begins to occur	incorrect
MC	The P wave in an ECG represents:	depolarisation of the atria	correct	contraction of the atria	incorrect	depolarisation of the ventricles	incorrect	repolarisation of the atria	incorrect
MC	The QRS complex in a normal ECG represents	depolarisation of the ventricles	correct	contraction of the ventricles	incorrect	repolarisation of the ventricles	incorrect	depolarisation of the atria	incorrect
MC	The T wave in an ECG complex	repolarisation of the ventricles	correct	relaxation of the ventricles	incorrect	depolarisation of the ventricles	incorrect	repolarisation of the atria	incorrect
MC	Identify the correct process: in gas exchange, oxygen:	diffuses across the alveolar-capillary membrane moving from a high concentration of oxygen to a lower concentration of oxygen	correct	is actively transported across the alveolar-capillary membrane	incorrect	diffusion is dependent on the amount of CO2 present	incorrect	diffuses across the alveolar-capillary membrane moving from a low concentration of oxygen to a higher concentration of oxygen	incorrect
MC	Identify the correct process: in gas exchange, carbon dioxide:	diffuses across the alveolar-capillary membrane moving from a high concentration of CO2 to a lower concentration of CO2	correct	is actively transported across the alveolar-capillary membrane	incorrect	diffusion is dependent on the amount of O2 present	incorrect	diffuses across the alveolar-capillary membrane moving from a low concentration of CO2 to a higher concentration of CO2	incorrect
MC	Normally, a person’s heart rate is modulated by:	both the parasympathetic and the sympathetic nervous systems	correct	just the sympathetic nervous system	incorrect	just the parasympathetic nervous system	incorrect	the cerebral cortex	incorrect
MC	The normal respiratory centre response to increasing blood levels of CO2 is:	increased respiratory rate	correct	decreased respiratory rate	incorrect	increased BP	incorrect	decreased HR	incorrect
MC	The normal average HR is	60-100bm	correct	60-70bpm	incorrect	40-85bpm	incorrect	80-100bpm	incorrect
MC	How many oxygen molecules	4	correct	3	incorrect	5	incorrect	2	incorrect

	bind to one haemoglobin molecule?								
MC	What are the long term physiological effects or exercise?	increased exercise capacity, increased strength, increased capillary density	correct	increased exercise capacity, increased strength, increased BP	incorrect	increased exercise capacity, increased strength, improved balance	incorrect	increased exercise capacity, increased strength, reduced myoglobin	incorrect
MC	What are the short term physiological effects of exercise?	increased HR, increased RR, increased BP,	correct	decreased HR, decreased RR, decreased BP,	incorrect	increased HR, decreased RR, decreased BP,	incorrect	decreased HR, decreased RR, increased BP,	incorrect
MC	All the following statements about the brain stem and its role in ventilatory control are true for people without a lung pathology EXCEPT	Its chemoreceptors are sensitive to changes in arterial pO2	correct	Its chemoreceptors are sensitive to changes in CSF pH	incorrect	Its chemoreceptors are not directly sensitive to small changes in arterial pH	incorrect	It contains neurons which generate the breathing rhythm	incorrect
	Applied physiology								
MC	In a self ventilating adult (with no lung pathology), sitting upright, ventilation is greatest	in the most dependent regions	correct	in the uppermost areas of lung	incorrect	in the left lung	incorrect	in the right lung	incorrect
MC	In a self ventilating adult, sitting upright, perfusion is greatest	in the most dependent regions	correct	in the uppermost areas of lung	incorrect	in the left lung	incorrect	in the right lung	incorrect
MC	In a self ventilating adult (with no lung pathology), in right side lying, ventilation is greatest	in the right lung	correct	in the uppermost areas of lung	incorrect	in the left lung	incorrect	in the basal regions	incorrect
MC	Which position would optimise V/Q matching in a self ventilating adult with a right sided lung pathology	left side lying	correct	right side lying	incorrect	supine	incorrect	upright sitting	incorrect
TF	CO2 has a greater affinity for haemoglobin: True or False	CO2	correct						
MC	Which of the following would NOT accelerate oxygen unloading from haemoglobin within tissues:	a decrease in blood pCO2	correct	an increase in body temperature	incorrect	a decrease in blood pH	incorrect	an increase in blood pCO2	incorrect

MC	Select the normal range of pO2 in healthy human arterial blood (in kPa)	10.7 - 13.3	correct	11.5 - 15.3	incorrect	8.2 - 11.8	incorrect	13.3 - 14.6	incorrect
MC	Select the normal range of pCO2 in healthy human arterial blood (in kPa)	4.5 - 6	correct	3.5 - 4.5	incorrect	4.8 - 7.2	incorrect	6 - 7.5	incorrect
MC	Select the normal range of HCO3- in healthy human arterial blood (in mmmol/L)	22 - 26	correct	18 - 22	incorrect	22 - 24	incorrect	24 - 32	incorrect
MC	The majority of CO2 in the blood is transported as:	bicarbonate	correct	carboxyhaemoglobin	incorrect	carbamino proteins	incorrect	carbonic acid	incorrect
MC	Which of the following is correct in relation to the isothermic saturation boundary located near the carina in the lungs	it moves down when someone is breathing dry gas	correct	it moves up when someone breathes dry gas	incorrect	it moves down with the presence of a warm water humidifier in an oxygen delivery circuit	incorrect	it moves up in cases of dehydration	incorrect
MC	Select from the following list the best description of these arterial blood gases: pH = 7.31; pCO2 = 9 kPa; pO2 = 7 kPa; HCO3- = 24 mmol/l; B.E. = 1	respiratory acidosis	correct	respiratory alkalosis	incorrect	metabolic acidosis	incorrect	metabolic alkalosis	incorrect
MC	Which one of the following would NOT cause a raised pCO2:	hyperventilation	correct	hypoventilation	incorrect	significant sputum retention	incorrect	significant bronchoconstriction	incorrect
MC	How would you describe the following arterial blood gases : pH = 7.5; pCO2 = 3kPa; pO2 = 13kPa; HCO3- = 23; BE -1	uncompensated respiratory alkalosis	correct	uncompensated respiratory acidosis	incorrect	uncompensated metabolic alkalosis	incorrect	uncompensated metabolic acidosis	incorrect
MC	All of the following cause metabolic acidosis EXCEPT	vomiting	correct	Aspirin overdose	incorrect	sepsis	incorrect	renal failure	incorrect
MC	The body's normal respiratory response to raised hydrogen ions (acidity) would be:	increased RR	correct	decreased RR	incorrect	increased HR	incorrect	decreased HR	incorrect
MC	Hypoxaemia is:	reduced oxygen in arterial blood	correct	reduced oxygen in the atmosphere	incorrect	reduced extraction coefficient of O2	incorrect	reduced oxygen at tissue level	incorrect
MC	Metabolic responses to sustained changes in Hydrogen ions can be delayed by approximately how long?	24 hours	correct	7 days	incorrect	72 hours	incorrect	1 month	incorrect

MC	Complete the following sentence: metabolic compensation for respiratiry acidosis involves	increasing the reabsorption of bicarbonate ions by the kidneys thereby increasing the amount of circulating HCO3 ions	correct	inhibiting the reabsorption of bicarbonate ions by the kidneys thereby reducing the amount of circulating HCO3 ions	incorrect	increasing the tidal volume and RR to reduce the amount of CO2	incorrect	reducing the tidal volume and RR to increase the amount of CO2	incorrect
MC	The cardiovascular response to low circulating blood volume (hypovolaemia) is:	incrased HR	correct	decreased HR	incorrect	relaxation of vascular tone to reduce blood flow resistance	incorrect	decreased cardiac contractility	incorrect
	Clinical assessment								
MA	Hypovolaemia can cause (tick all that are appropriate)	high HR	correct	low BP	correct	low urine out-put	correct	low RR	incorrect
MC	Coarse inspiratory crackles on auscultation can represent	intermittent airway closure and opening	correct	bronchoconstriction	incorrect	consolidation	incorrect	fluind in the pleura	incorrect
MC	Stridor (upper airway partial obstruction) can be described on auscultation as:	monophonic inspiratory wheeze	correct	polyphonic expiratory wheeze	incorrect	inspiratory crackles	incorrect	expiratory crackles	incorrect
MC	Widespread bronchospasm often presents on auscultation as	polyphonic expiratory wheeze	correct	monophonic inspiratory wheeze	incorrect	inspiratory crackles	incorrect	expiratory crackles	incorrect
MC	Which of the following would NOT indicate the presence of an infection	increased urine out-put	correct	increased temperature	incorrect	increased white cell count	incorrect	increased CRP	incorrect
MC	Which of the following could NOT be the cause of asymmetrical chest wall movement	widespread bronchoconstriction	correct	unilateral pneumothorax	incorrect	unilateral pleural effusion	incorrect	unilateral pneumonia	incorrect
MA	Which of the following may indicate the presence of pain (tick all that are correct)	increased urine out-put	correct	high HR	correct	high BP	correct	pallor	correct
MC	Bronchial breath sounds often represent:	consolidation	correct	sputum	incorrect	bonchoconstriction	incorrect	pneumothorax	incorrect
MA	Which of the following are examples of increased work of breathing (tick all that are correct)	accessory muscle use	correct	paradoxical chest wall movement	correct	bucket handle movement of the ribcage	incorrect	pump handle movement of the sternum	incorrect
MC	An irregular P wave on ECG could indicate:	atrial fibrillation	correct	ventricular fibrillation	incorrect	ventricular tachycardia	incorrect	asystole	incorrect
MA	Observing ‘Pallor’ in a patient could indicate:(tick all that could be correct)	low Hb	correct	pain	correct	low BP	correct	bronchospasm	incorrect

MA	What can fluid balance give an indication of?	whether a patient is dehydrated	correct	whether a patient has fluid retention	correct	whether a patient's renal system is working effectively	correct	whether a patient has sputum retention	incorrect
MC	Why should you check the full blood count of an acutely unwell patient?	to check for signs of infection	correct	to check levels of hydration	incorrect	to check for cardiovascular instability	incorrect	to check for respiratory insufficiency	incorrect
MA	What information is important to ascertain from the operation/anaesthetic notes of a patient who has recently undergone surgery? (tick all of that are appropriate)	any post-operative instructions from the surgical team	correct	whether the operation was straighforward	correct	whether the patient was cardiovascularly stable throughout the proceedure	correct	whether the swab/instrument count was correct	incorrect
MA	What HPC information is important when assessing an acutely unwell COPD patient? (tick all that are appropriate)	history of onset	correct	how their symptoms are different to normal	correct	work of breathing	correct	oxygen requirements	correct
MA	What background information is important to collate when assessing a stable COPD patient? (tick all that are appropriate)	normal exercise tolerance	correct	normal sputum production	correct	history of exacerbations/recent admissions to hospital	correct	normal respiratory medications	correct
MC	If you observe ankle oedema in a patient, what other objective assessment information should you check?	fluid balance	correct	temperature	incorrect	RR	incorrect	chest wall symmetry	incorrect
MA	If you review a patient 1 day post-op what TYPES of drugs would you expect to see on their drug kardex	antibiotics	correct	analgesics	correct	diuretics	incorrect	bronchodilators	incorrect
MA	If you review a patient with a history of cardiac problems what TYPES of drugs might be present on their kardex	diuretics	correct	anti-hypertensives	correct	statins	correct	bronchodilators	incorrect
MA	If you review a patient with a history of respiratory problems what TYPES of drugs might be present on their kardex	bronchodilators	correct	steroids	correct	antibiotics	correct	diuretics	incorrect
	Pathology								
MC	Which of the following describes a pneumothorax	air in the pleural cavity	correct	blood in the pleural cavity	incorrect	fluid in the pleural cavity	incorrect	bullae on the surface of the lung	incorrect
MC	Which of the following describes a pleural effusion	fluid in the pleural cavity	correct	air in the pleural cavity	incorrect	thickening of the pleural membrane	incorrect	blood in the pleural cavity	incorrect

MC	Which of the following describes pulmonary oedema	fluid within the alveoli	correct	fluid within the pleural cavity	incorrect	thickening of the alveoli	incorrect	sputum within the alveoli	incorrect
MC	Which of the following describes asthma	inflammation and constriction of the bronchi and bronchioles	correct	inflammation and constriction of the alveoli	incorrect	inflammation and constriction of the pharynx	incorrect	inflammation and constriction of the bronchioles and alveoli	incorrect
MC	Which of the following is the definition of COPD	A condition causing airflow obstruction which is usually progressive and not fully reversible	correct	A condition causing airflow obstruction which is not progressive and fully reversible	incorrect	A condition causing restriction of lung volumes which is usually progressive	incorrect	A condition causing restriction of lung volumes which is not progressive	incorrect
MA	General anaesthesia can cause (tick all that are appropriate)	reduction in FRC	correct	impaired mucociliary function	correct	reduced hydration throughout respiratory tract	correct	pain	incorrect
MC	Which of the following does NOT increase the risk of post operative respiratory complications	an epidural	correct	smoking	incorrect	obesity	incorrect	increasing age	incorrect
MA	Atelectasis can be caused by the following (tick all that are appropriate)	sputum retention	correct	increased abdominal loading	correct	impaired mucocilliary transport	correct	respiratory failure	incorrect
MC	Haemoptysis can indicate all of the following EXCEPT	lung abscess	correct	respiratory carcinoma	incorrect	TB	incorrect	asthma	incorrect
MC	Which of the following in mainly a restrictive disorder	fibrosing alveolitis	correct	chronic bronchitis	incorrect	asthma	incorrect	consolidation	incorrect
MC	Pulmonary oedema as a result of left ventricular heart failure is caused by:	Increased hydrostatic pressure within the pulmonary circulation	correct	Reduced osmotic pressure within the pulmonary circulation	incorrect	Decreased hydrostatic pressure within the cardiac circulation	incorrect	Increased osmotic pressure within the pulmonary circulation	incorrect
MA	Emphysematous changes in the lungs include (tick all that apply)	Loss of alveolar walls	correct	Loss of radial traction around extra-alveolar blood vessels	correct	Reduced lung elastic recoil	correct	Hypertrophy of the bronchial mucous glands	incorrect
MC	Pneumonia is characterised by	high temperature, unproductive cough, consolidation	correct	high temperature, productive cough, secretion retention	incorrect	normal temperature, fluid filled alveoli, productive cough	incorrect	normal temperature, sputum retention, productive cough	incorrect
MC	Consolidation can be described as	fluid within the alveoli that has become solid due to exudate from the inflammatory process	correct	sputum within the alveoli that requires assistance to mobilise	incorrect	fluid within the alveoli generated by increased hydrostatic pressure from pulmonary circulation	incorrect	complete collapse of an alveolus inhibition the movement of secretions	incorrect
MC	The incision site for a laparotomy is	vertical midline, abdominal	correct	horizontal midline, abdominal	incorrect	oblique angle, thorax	incorrect	vertical midline, thorax	incorrect

MC	The incision site for a mediansternotomy is	vertical midline, thorax	correct	vertical midline, abdominal	incorrect	oblique angle, thorax	incorrect	horizontal line, thorax	incorrect
MA	Stage III Cardiac rehabilitation is appropriate for which groups of patients (tick all that apply)	patients following cardiac surgery	correct	patient following myocardia infarction	correct	patients with cardiac failure	correct	patients with unstable angina	incorrect
MA	Pulmonary rehabilitation is appropriate for which groups of patients (tick all that apply)	patients with chronic bronchiectasis	correct	patients with COPD	correct	patients with cardiac failure	incorrect	patients with brittle asthma	incorrect
MA	Why might you be referred a patient following an Abdominal surgery? (tick all that apply)	incision site may impact on cough efficacy due to pain	correct	mucociliary clearance is impaired due to anaesthesia	correct	patients may experience prolonged bed rest impacting on lung volumes	correct	patients may require rehabilitation	correct
MA	Patients with neuromuscular disorders are at risk of cardio-respiratory compromise because (tick all that apply)	altered respiratory mechanics may impair tidal volume	correct	reduced muscle strength may reduce cough efficacy	correct	lack of muscle tone may reduce functional residual capacity causing atelectasis	correct	altered respiratory mechanics may reduce expiratory reserve volume	incorrect
	Treatments								
MC	The Flutter device works by:	generating an oscillatory PEP causing increased sputum mobilisation	correct	creating a back-pressure in the lungs increasing collateral ventilation	incorrect	encouraging patients to utilise their Inspiratory Reserve Volume	incorrect	Generating a negative pressure causing increased expiratory flow	incorrect
MA	The positive effects of re-positioning a patient can include: (tick all that apply)	improved V/Q	correct	improved respiratory mechanics	correct	improved lung volumes	correct	improved urine output	incorrect
MA	The negative side effects of re-positioning a patient can include: (tick all that apply)	reduced BP	correct	pain	correct	V/Q mismatch	correct	reduced urine output	incorrect
MC	The Positive expiratory Pressure device works by:	creating a back-pressure in the lungs increasing collateral ventilation and mobilisation of secretions	correct	increasing inspiratory volumes	incorrect	generating turbulence during inspiration	incorrect	augments breathing control	incorrect
MA	Indications for using a PEP device include (tick all that apply)	Post-operative atelectasis	correct	Bronchiectasis	correct	Cystic Fibrosis	correct	Pulmonary oedema	incorrect
MC	In which of the following clinical situations would you consider using CPAP as a first line of treatment	severe type I respiratory failure with loss of lung volume	correct	severe type II respiratory failure with known obstruction	incorrect	high levels of respiratory distress and confusion	incorrect	PO2 of 10KPa on 31% oxygen through a fixed delivery device	incorrect

MC	In which of the following clinical situations would you consider using BiPAP as a first line of treatment	severe type II respiratory failure with a pH greater than 7.25	correct	severe type I respiratory failure with loss of lung volume	incorrect	high levels of respiratory distress and confusion	incorrect	PO2 of 10KPa on 31% oxygen through a fixed delivery device	incorrect
MC	Choose from the following combinations to describe the components of ACBT	breathing control; thoracic expansion; forced expiratory technique	correct	thoracic expansion; incentive spirometry; cough	incorrect	deep breathing; pursed lip breathing; forced expiratory technique	incorrect	diaphragmatic breathing, pursed lip breathing; thoracic expansion	incorrect
MA	Which of the following positions can optimise breathing mechanics/WOB in an acutely breathless patient	forward lean sitting	correct	upright sitting	correct	high side lying	correct	supine	incorrect
MC	Which of the following physiological principles best describes the mechanism of action of FET	the movement of the equal pressure point	correct	the optimisation of gravity	incorrect	the enhancement of elastic recoil	incorrect	the creation of a positive end expiratory pressure	incorrect
MC	Which of the following is NOT an indication for humidification	pulmonary oedema	correct	high flow oxygen and accompanying secretion retention	incorrect	when the upper respiratory tract is bypassed	incorrect	when secretions are thick and sticky	incorrect
MC	Which of the following is NOT true about oxygen therapy	fixed performance devices are determined by oxygen flow rate alone	correct	FiO2 can be expressed as a fraction and as a percentage	incorrect	high percentages of O2 can cause atelectasis	incorrect	a high FiO2 can be created by using a reservoir mask	incorrect
MC	BiPAP improves which lung volumes	tidal volume and functional residual capacity	correct	tidal volume and residual volume	incorrect	inspiratory capacity and residual volume	incorrect	tidal volume and expiratory reserve volume	incorrect
MC	What initial percentage of inhaled oxygen would be appropriate for someone with COPD having a severe exacerbation	24%	correct	28%	incorrect	31%	incorrect	40%	incorrect
MA	What are possible side effects of sitting a post-operative patient out of bed (tick all that apply)	a drop in blood pressure	correct	pain	correct	breathlessness	correct	a reduction in urine output	incorrect
MC	Which of the following is NOT a contraindication for positioning	high RR	correct	a non-immobilised cervical spine injury	incorrect	severe cardiovascular instability	incorrect	significantly raised intracranial pressure	incorrect
MC	When might you use an incentive spirometer	when a patient is on prolonged bed rest and is showing signs of reduced lung volumes	correct	for a patient who is acutely breathless	incorrect	during a severe acute exacerbation of COPD	incorrect	a patient with a high oxygen requirement (more than 40%)	incorrect

MC	What lung volume is primary utilised when using an incentive spirometer	inspiratory reserve volume	correct	tidal volume	incorrect	expiratory reserve volume	incorrect	functional residual capacity	incorrect
MC	When might a flutter device be indicated	significant sputum retention without an oxygen requirement	correct	Post-operative patients presenting with atelectasis	incorrect	sputum retention with a high RR	incorrect	pneumothorax	incorrect
MC	How does an in-exsufflation device work	augments a larger tidal volume and generates a high expiratory flow	correct	mimics a cough	incorrect	synchronises with a patient's breathing	incorrect	generates turbulent flow on expiration	incorrect

Appendix 12: Self-Assessment Questionnaire

Respiratory Physiotherapy - self assessment questionnaire

The purpose of this self-assessment questionnaire is to help you to identify your strengths and weaknesses within respiratory physiotherapy.

The questionnaire is split into sections to help you consider different aspects of your knowledge from assessment and problem identification, to your understanding of practical skills for a wide range of clinical areas. Each section has a number of statements that you are asked to grade from 'strongly agree' to 'strongly disagree'.

*Required

1. **Student Number** *

Please consider your knowledge and skills in respiratory physiotherapy in light of the questions below

Use your answers to identify and prioritise your learning needs for this area of practice.

2. **Patient assessment** *

Mark only one oval per row.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
The information I collect is accurate and appropriate	◯	◯	◯	◯	◯
I know how to deal with a patient who is unable to give consent to assessment/treatment	◯	◯	◯	◯	◯
I can take an appropriate subjective history	◯	◯	◯	◯	◯
I can identify pertinent past medical history information	◯	◯	◯	◯	◯
I can identify and explain the purpose of commonly used drugs	◯	◯	◯	◯	◯
I am able to discuss with the patient (where possible) their key issues	◯	◯	◯	◯	◯
I can interpret patient records, notes and charts	◯	◯	◯	◯	◯
I can interpret monitoring equipment	◯	◯	◯	◯	◯
I can observe the patient's breathing and general status and identify significant findings	◯	◯	◯	◯	◯
I can use a stethoscope and interpret auscultation findings	◯	◯	◯	◯	◯
I can palpate respiratory movements and identify significant variations	◯	◯	◯	◯	◯
I can interpret arterial blood gases	◯	◯	◯	◯	◯
I can identify chest X-ray findings of relevance to physiotherapy	◯	◯	◯	◯	◯
I am able to assess a patient's cardiovascular status	◯	◯	◯	◯	◯

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I can interpret blood results that are of relevance to physiotherapy					
I am able to assess a patients fluid balance and understand its relevance to my assessment					

3. **Problem identification** *
Mark only one oval per row.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I can analyse my assessment findings					
I can identify a patient who is deteriorating or becoming critically ill					
I can identify the patient's main respiratory problems					
I can prioritise the patient's main respiratory problems					
I can identify relevant social and emotional factors that might impact on treatment					
I can select appropriate outcome measures that enable me to evaluate my intervention					

4. **I feel able to ....** *
Mark only one oval per row.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Produce an appropriate treatment plan					
Discuss my treatment plan with patients and carers					
Implement, evaluate and adapt my treatment plan					
Identify my limitations and refer on to others					
Treat problems associated with loss of lung volume					
Treat problems associated with acute sputum retention					
Treat problems associated with chronic sputum retention					
Treat problems associated with increased work of breathing					
Take appropriate action for patients who deteriorate or become critically ill					
Treat reduced exercise capacity as a result of respiratory illness					
Treat reduced exercise capacity as a result of cardiovascular illness					

5. **I know the indications, mechanisms of action, contraindications and how to safely implement..... ***

Mark only one oval per row.

	strongly agree	agree	neither agree nor disagree	disagree	strongly disagree
Positioning and Postural drainage	◯	◯	◯	◯	◯
Active Cycle of Breathing Technique/breathing exercises	◯	◯	◯	◯	◯
Flutter/Acapella/Cornet	◯	◯	◯	◯	◯
Positive Expiratory Pressure (PEP)	◯	◯	◯	◯	◯
Manual techniques - Shakes/Vibs	◯	◯	◯	◯	◯
Manual techniques - Percussion	◯	◯	◯	◯	◯
Non-Invasive Ventilation - CPAP	◯	◯	◯	◯	◯
Non-Invasive Ventilation - BiPAP	◯	◯	◯	◯	◯
In-Ex sufflation - Cough Assist	◯	◯	◯	◯	◯
Suction (Open: n-p / oral)	◯	◯	◯	◯	◯
Suction (Closed: ventilated patients)	◯	◯	◯	◯	◯
Advice regarding the management of long term breathing difficulties e.g. pacing	◯	◯	◯	◯	◯
Exercise prescription	◯	◯	◯	◯	◯

6. **I feel able to perform a safe and effective assessment and identify physiotherapeutic needs of .... ***

Mark only one oval per row.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Adults in the community setting	◯	◯	◯	◯	◯
Adults within their home environment	◯	◯	◯	◯	◯
Adults on general wards	◯	◯	◯	◯	◯
Adults on high dependency units	◯	◯	◯	◯	◯
Adults on intensive care units	◯	◯	◯	◯	◯
Adults on neurosurgical units	◯	◯	◯	◯	◯
Adults following abdominal surgery	◯	◯	◯	◯	◯
Adults following cardiothoracic surgery	◯	◯	◯	◯	◯
Adults with acute respiratory disease	◯	◯	◯	◯	◯
Adults with chronic respiratory disease	◯	◯	◯	◯	◯
Adults on ventilators	◯	◯	◯	◯	◯
Adults with tracheostomies	◯	◯	◯	◯	◯
Adults with cardiovascular rehabilitation requirements	◯	◯	◯	◯	◯
Adults with respiratory rehabilitation requirements	◯	◯	◯	◯	◯

7. **I have had direct clinical experience with .... ***

Please tick 'Yes' if you have assessed or treated any of the following on clinical placement

Mark only one oval per row.

	Yes	No
Adults in the community setting	◯	◯
Adults within their home environment	◯	◯
Adults on general wards	◯	◯
Adults on high dependency units	◯	◯
Adults on intensive care units	◯	◯
Adults on neurosurgical units	◯	◯
Adults following abdominal surgery	◯	◯
Adults following cardiothoracic surgery	◯	◯
Adults with acute respiratory disease	◯	◯
Adults on ventilators	◯	◯
Adults with tracheostomies	◯	◯
Adults with cardiovascular rehabilitation requirements	◯	◯
Adults with respiratory rehabilitation requirements	◯	◯

Appendix 13: Module Evaluation Form

Module evaluation

*Required

Please consider your experience of the PRP module in relation to the statements below

You are asked to grade your response from 'definitely disagree' to 'definitely agree'.

1. **Your expectations of the module** *

Mark only one oval per row.

	definitely disagree	mostly disagree	neither agree nor disagree	mostly agree	definitely agree
I was made aware of the module's learning objectives at the outset	⬭	⬭	⬭	⬭	⬭
I was given an overview of the module content at the start of the module	⬭	⬭	⬭	⬭	⬭
I knew what was expected of me within the module	⬭	⬭	⬭	⬭	⬭

2. **Teaching and learning opportunities** *

Mark only one oval per row.

	definitely disagree	mostly disagree	neither agree nor disagree	mostly agree	definitely agree
An appropriate range of topics were covered in the module	⬭	⬭	⬭	⬭	⬭
Staff were good at explaining things	⬭	⬭	⬭	⬭	⬭
Staff have made the subject interesting	⬭	⬭	⬭	⬭	⬭
The learning/teaching activities helped improve my understanding	⬭	⬭	⬭	⬭	⬭
The video/interactive workbooks helped improve my understanding	⬭	⬭	⬭	⬭	⬭
The 3D resources helped improve my understanding	⬭	⬭	⬭	⬭	⬭
Using the iPads in sessions helped me access more resources	⬭	⬭	⬭	⬭	⬭
Using the iPads in the session improved the group activities	⬭	⬭	⬭	⬭	⬭
Using Simman helped improve my understanding of cardio-respiratory assessment	⬭	⬭	⬭	⬭	⬭
The library and resources on Blackboard helped my learning	⬭	⬭	⬭	⬭	⬭
I have been able to access specialised equipment/facilities when needed	⬭	⬭	⬭	⬭	⬭

3. **Assessment** *
Mark only one oval per row.

	definitely disagree	mostly disagree	neither agree nor disagree	mostly agree	definitely agree
The assessment tasks were explained at the start of the module					
I understand how the assessment was relevant to my learning for this module					
The assessment tasks were at the right time within the module					
The assessment tasks were at the right time in relation to other modules					
The criteria used for marking was made clear					
Assessment arrangements and marking have been fair					

4. **Feedback and support** *
Mark only one oval per row.

	definitely disagree	mostly disagree	neither agree nor disagree	mostly agree	definitely agree
I have received sufficient advice and support with my studies					
I have been able to contact staff when I needed to					
I was able to get timely advice on my learning					
I was given some feedback on my work during the module					
Arrangements for receiving feedback on assessment tasks were made clear					
The feedback on my assessment helped me identify what i did well					
The feedback on my assessment helped me to identify how to improve					

5. **Organisation** *
Mark only one oval per row.

	definitely disagree	mostly disagree	neither agree nor disagree	mostly agree	definitely agree
The timetable worked efficiently for this module					
Any changes in the teaching were communicated effectively					
The module was well organised and ran smoothly					
The module was appropriately timetabled in relation to other modules					
Teaching sessions were timed appropriately within the module					

6. **Our responsiveness to your feedback** *
Mark only one oval per row.

	definitely disagree	mostly disagree	neither agree nor disagree	mostly agree	definitely agree
I have had opportunities to provide feedback on this module					
The teaching team listened to and valued my feedback					
I can see how my feedback has been/will be acted upon					

7. **Engagement, performance and personal developments** *
Mark only one oval per row.

	definitely disagree	mostly disagree	neither agree nor disagree	mostly agree	definitely agree
I have attended the majority of my teaching sessions	⬭	⬭	⬭	⬭	⬭
I have done the preparation required (e.g. reading papers / gathering information)	⬭	⬭	⬭	⬭	⬭
The materials we were given helped me to understand the module	⬭	⬭	⬭	⬭	⬭
I have engaged in self-study, developing notes, reading relevant texts etc	⬭	⬭	⬭	⬭	⬭
The module has helped me develop my learning	⬭	⬭	⬭	⬭	⬭
The module has helped me identify ongoing learning needs	⬭	⬭	⬭	⬭	⬭
I can see how my learning from the module is relevant to my future career	⬭	⬭	⬭	⬭	⬭
It is clear to me how this module fits with the course as a whole	⬭	⬭	⬭	⬭	⬭
I have reflected on my learning in this module in my portfolio/personal development planning	⬭	⬭	⬭	⬭	⬭

8. **Overall MODULE satisfaction** *
Mark only one oval per row.

	definitely disagree	mostly disagree	neither agree nor disagree	mostly agree	definitely agree
Overall I am satisfied with the quality of the module	⬭	⬭	⬭	⬭	⬭

9. **Please identify the 3 most positive aspects of the module**

10. **Please identify up to 3 things you would like to see changed about the module (and why)**

11. **Please elaborate on any questions you answered 'mostly disagree' or 'definitely disagree'**
What could be done to improve these aspects?

12. **Is there anything else you wish to tell us about the module?**