AN EXPLORATION OF THE INFLUENCE OF MOBILE TECHNOLOGIES ON PRE-REGISTRATION PHYSIOTHERAPY STUDENT LEARNING.

Michael Kenneth Parr

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Abstract

BACKGROUND: Educational learning that is mediated by mobile i.e., tablets, mini-tablets and mobile phones, has gained popularity due to the ubiquitous nature of these types of technology and their ability to provide free and autonomous learning. Given that estimations of mobile user numbers by 2023, are projected at 7.26 billion, there is considerable interest in this area. Mobile has the potential to promote authentic learning but also, the ability to distract and therefore is eschewed by some learners and educators alike. Acceptance of mobile for learning has been explored through various acceptance models, however these usually apply to institutionally selected technology. This study proposes to explore acceptance and influence of personal mobile technologies using a group of pre-registration student studying physiotherapy.

RESEARCH QUESTION:

How does a pre-registration student physiotherapy population use mobile mediated learning as a vehicle for learning in a specific professional context?

STUDY AIM: To explore how mobile technology is used by pre-registration physiotherapy students and identify the influence that mobile mediated learning plays in their professional development.

METHODOLOGY: A sequential explanatory mixed-methods paradigm around technology acceptance and learning theory utilised quantitative statistical analysis and a framework data handling and analysis approach.

METHODS: A survey questionnaire was developed and was used to gather opinion statements using convenience sampling, (n=163), around the usefulness of mobile mediated learning. Factor analysis was used to identify three separate constructs within the questionnaire and a further hierarchical cluster analysis identified three independent groups within the sample. Kruskal-Wallis tests showed significant differences between the constructs in the three groups, showing different levels of acceptance. This data was used to identify participants for semi-structured interviews who were recruited using a maximum variance sample. Follow up semi-structured interviews were conducted with 23 participants, who were purposively selected from each of the groups to investigate the acceptance and influence of mobile technology in greater depth.

RESULTS: Analysis of questionnaires demonstrated significant differences across two of the questionnaire constructs between the groups. Semi-structured interviews identified four emergent themes, demonstrating that pre-registration physiotherapy participants use mobile mediated learning to develop clinical skills, primarily using self-created video. They favour an expeditious approach to learning and use mobile technologies as a support tool for learning, reflection, and collaboration. Differing levels of digital literacy mediated through mobile dictated the ability to overcome some barriers presented by mobile technology and

may help to foster a connected approach to learning, alongside longer established methods, such as written resources.

CONCLUSION: Mobile mediated learning is an important support tool that can help develop clinical skills and competencies through use of self-created and publicly available video. It engages learners due to its ease of use and helps facilitate collaborative and individual learning through social media communications and face to face discussion. These may help facilitate both skill development (via multimedia) and cognitive understanding. The implicit nature of this, suggests that mediated mobile learning is understated and that educators can utilise both social learning theory and connectivist models to facilitate these skills. Additionally, institutions may consider how learners can address and overcome barriers to mobile learning if a connected approach is desirable.

Table of Contents

TABLE OF FIGURES, TABLES AND GRAPHS.

CHAPTER 2

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Prior to commencing this study, a wise man said to me that before contemplating a PhD, I should consider the commitment necessary to complete a thesis of this kind and ensure that the required support needed, was in place. The following words are dedicated to those who provided that support.

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Declaration.

I declare that the work contained in this thesis has not been submitted for any other award and that it is all my own work. I also confirm that this work fully acknowledges opinions, ideas, and contributions from the work of others.

Any ethical clearance for the research presented in this thesis has been approved. Approval has been sought and granted by the Northumbria University Faculty of Health and Life Sciences Research Ethics Review Panel on 14th November 2014 (Phase 1) and 9th May 2016 (Phase 2)

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Preface.

Almost a century has passed since the inventor and futurist Nikola Tesla proclaimed that a device small enough to fit into a vest pocket would be the instrument through which communication would occur irrespective of distance. The prophetic dialogue also predicted that the whole earth would become one gigantic brain through which a global connectivity would allow perfect wireless communication in which individuals would be able to see and hear each other as though "we were face to face despite the intervening distances of thousands of miles" (Tesla, 1926). This description perfectly describes access to the World Wide Web using wireless internet via pocket-size type computers and other hand-held technology such as touch screen tablet technology.

Just as Tesla predicted in the 1920s how communication strategies would change in the future, there are modern equivalents who predict how education will change in the decades to come (Facer, 2011, Bielsa, 2016) and how handheld devices may influence this. Much of the change that is predicted stems from behavioural change that is often associated with social change such as that during the industrial and agricultural revolutions. Education has already mirrored some of the social change in communication by offering digital choices such as distance learning through open online courses that were previously unavailable, but what are the drivers behind these choices?

Although there is much to applaud and deliberate today, regarding the uncanny accuracy of Tesla's statement, it is perhaps pertinent to reflect that the research in the areas of conceptual frameworks, pedagogy, and social aspects of learning link to the advances in global communication. These have had influences far beyond simple digital communication dialogues and indeed have shaped and affected many facets of life in general. It is perhaps the previous two decades that have demonstrably shown rapid change in this regard (Frey, 2017), to the extent that the 21st Century is regarded as the 'Third Revolution' after the Agricultural and Industrial Revolutions of the mid-17th and early 18th Centuries (Ashton, 1997). This thesis aims to explore if the digital choices afforded by the rise of mobile devices and mobile mediated learning have influenced learning within the physiotherapy student population and gain an understanding of student opinions with respect to the value of these devices within the context of physiotherapy education.

Chapter 1: Introduction.

The rapid development in mobile technology was predicted to change the way that education is delivered (Ally, et al. 2014) as the world became increasingly connected and mobile. Today, the global population are using phones for socialisation, to search for information, to conduct business and to relax with leisure type gaming. The growth of these technologies presents an opportunity for learners to use phones for learning purposes at a time and place of their own choosing. Presently, mobile devices, which can be defined as any device where it is possible to use with two hands whilst standing up or on the move (Quinn, 2013) are single multi-purpose computers with multi-core processors that feature high resolution capabilities and network connectivity. Currently, their worldwide use is outpacing the traditional desktop computer with a predicted worldwide use of 7.26 billion mobile users by 2023 (Statista, 2019). Unsurprisingly, this has created a great deal of interest around the uses of mobile technologies for educational usage at all levels, particularly as the largest demographic of mobile users are aged between 18 and 29 (Crompton and Burke, 2018). Bosomworth, (2015) reports however, that people do not always use their mobiles for learning purposes, they use their mobiles to search for information, to read the news or to play games on.

More and more learners, however, are being pulled into the culture of mlearning for social media interactions to stay in touch. Access to video-based platforms has enabled a change in learning methods that have effectively ‘flipped’ the traditional approach of absorbing subject material during contact hours and practice at home, to an approach which enables students to study material at home in addition to skills instruction and practice/discuss during contact hours. This approach facilitates the transition to fewer contact hours in skills-based modules and equity of demonstration for all students who access such video-based platforms. The ease of access via mlearning (e.g., tablet) technologies facilitates a better environment for practice in both home and University practice environments (Sergio, 2013).

There is much research around user readiness towards the adoption of technology. Motiwalla, (2007) and Park, (2011) outlined the challenges in the adoption of mobile technology and the need for assessments of readiness to be developed (Corbeil and Valdes-Corbeil, 2007). Indeed, several models do exist that explore theories of acceptance such as Davis' 1989 Technology Acceptance Model (Davis, 1989) Theory of Reasoned Action (Fishbein and Ajzen, 1976), Theory of Planned Behaviour (Ajzen, 1991) etc. The Technology Acceptance Model is a widely used model due to its simplicity and applicability in many areas of technology including Web 2.0 technologies such as email (Adams, Nelson, and Todd, 1992) and the Internet (Lederer, et al., 2000), however these models are used mainly for institutional rather than personal technology acceptance.

Descriptions of an 'Information Age' or 'Digital Revolution' are now common associations with the late 20th and early 21st Centuries and perhaps describe the weight of change in how individuals now engage with information. Much as the Industrial Revolution saw a change from systems of hand production methods and techniques to the use of machinery, steam power and the rise of a factory system, the digital revolution has seen changes in technology, from analogue to digital, and from print based to online resources. The social change that occurred due to the mechanisation of industry saw a migration in the population from rural to urban areas and may be likened to the digital revolution that has seen social change in the way that information is now accessed and how communication and collaboration occurs. Both Russell, Bebell and O'Dwyer, (2003), and Pedro, (2007) describe that access to information and communication is more widely available at home than in the classroom and, that exposure to digital resources shapes both patterns of thinking and communication. This effectively influences their personal and social values through exposure to various notions of communication and control and promotes autonomy about learning choices. The ability to engage and communicate with a digital audience is one example of how social change has been influenced by the digital revolution.

The debate around how mobile technology will shape Health-Based Higher Education is an interesting one when one considers the wider impact that technology is set to play on both Higher Education generally and for the job-preparedness of today's graduates. Glenn, (2008) suggests that technology has and will continue to have a significant impact on Higher Education with mobile learning technologies gaining a firm foothold in universities around the world. University respondents report that these new technologies now have a significant, positive impact on their campuses, both nationally and internationally (Glenn, 2008). With an expectation that an overseas student presence will increase in the coming years, learning flexibility via these emerging technologies offers significant opportunities for the future.

Teo and Zhao, (2017) describe many additional factors around this that range from generational debates (millennial learners, generation Y, generation X etc.), acceptance of technology theories, perceived ease of use and usefulness, normative beliefs, financially driven decisions of manufacturers and consumers, and theories of learning associated with direct and indirect social communication.

There are, however, few studies that investigate the combination of mobile technology use, acceptance and evaluation with the social aspects and experiences that these communications produce. Koole's (2009) FRAME model considers factors from three contexts, namely, the learner, the social aspect, and the device aspect. Herrington and Herrington, (2007) comment that the pedagogical use of powerful mobile technologies was not widespread in the early part of the millennia and studies showed that 'early adopters' were more willing to use these new technologies for learning purposes. However, it is not clear that a sound theoretical framework exists for the use of mobile technology in education, or what influence technology has on the overall theory and practice of health-based subjects such as Physiotherapy.

The need for health care practitioners such as physiotherapists to remain current with the latest evidence therefore fronts an interesting debate around the influence of mobile technology, its technological possibilities, and the future role it may play in graduate development. Given the abundance of available information around evidence-based healthcare, the need to stay current and up to date is hugely important. Health Education England, (2018) outline in the digital capabilities' framework, six generic domains and four ascending levels of competency that are identified with the goal of building a digital ready workforce within health care. This work is part of HEE's mandate from the Department of Health towards developing a digital agenda. Mobile devices such as Smartphones and tablets are included within two of the domains (Technical proficiency and teaching, learning and self-development). The commitment from central government to develop digital capability in health-care workforces highlights the importance of understanding the current acceptance and influence of mobile technology in these populations. Given the highly personal nature of mobile technology and the greater agency and choice afforded by untethered technology, the need to understand how these potentially disruptive technologies influence learning as a primary consideration.

As continuous learning is now a given for the younger generation with virtually all having a connected device to hand and with many primary, middle, and high schools now embracing tablet-based technologies within their curricula, expectations of university-based learning are perhaps shifting (Terry, et al. 2019). The opportunity, therefore, to investigate this further within a specific future healthcare workforce consisting of pre-registration physiotherapists would add a novel contribution to the understanding of the current digital capability and influence that it has on learning up to and including graduation.

This thesis will explore the influences upon theory and practice that mobile technologies offer pre-registration students of physiotherapy by examining the literature around learning theory prior to and including the digital revolution. It is the first study to explore the use and limitations of technology acceptance models with respect to personal technologies and the first to develop an mlearning questionnaires that investigates how personal digital technology for educational purposes has been accepted within a population of pre-registration physiotherapy students. The study phase consists of quantitative and qualitative phases that together, attempt to explain the influence of mobile technologies upon student learning with this group of learners. Do barriers exist with reference to the acceptance of technology, do generations of learners integrate with technology in a similar manner? Do the financial drivers that influence the use and integration of these devices into student learning have more of less influence? The study phase will explore these issues firstly, using a quantitative survey questionnaire and secondly, using semi-structured interviews to discover what influence these technologies have upon a group of pre-registration physiotherapy students in terms of the scope of use. The survey questionnaire will serve several other purposes as it will be used to develop a maximum variance sample for the subsequent in-depth interviews and be used to develop a reliable and validated predictive questionnaire around uses of personalised technology in learning.

The qualitative phase represents the first exploration of participant experiences using in-depth interviews in this population. Participants recruited from a subset of the questionnaire will be interviewed to explain what factors influence their decisions to engage with or ignore this technology for learning and what their opinions are regarding its usefulness. Finally, the thesis will attempt to integrate these findings and discuss the influence that these technologies contribute to pre-registration physiotherapy student learning to better understand how, as an educator, I may offer future pre-registration students' and fellow educators within Higher Education, practical advice with regards to their use and development of resources.

Aims.

The overall aims of this thesis are:

- To gain a better understanding of the use and range of mobile devices in a physiotherapy student population.
- To develop a rigorous, consistent, and valid questionnaire that measures different constructs of mobile learning in a physiotherapy student population.
- To explore to what extent opinions, vary regarding the influence of mobile learning and if these differences result in different behaviours around learning constructs.
- To explore experiences across a range of pre-registration student physiotherapists and understand what influence mobile technologies have on their learning.
- To utilise the qualitative evidence statements of physiotherapy students to better understand the factors that influence mobile technology acceptance in a learning context.
- To integrate findings and discuss the influence that mobile technologies contribute to pre-registration physiotherapy student learning

Chapter 2: Literature Review.

Overview.

This chapter will provide an overview of the research around mobile technology, the research questions, and the objectives of the research. An overview of learning theories will be presented, and the significance of the research will be articulated. Lastly, the research around social media and the specific physiotherapy literature will be explored to identify gaps and provide a rationale for this thesis.

The theoretical development of mlearning is still relatively young and while authors such as Sharples, et al. (2007), and Cochrane, (2007) have proposed theoretical frameworks for mlearning, e.g., activity theory, much of the development around a specific learning theory has been hampered by the rapid development of mobile technology. It is difficult to propose a contemporary theory when the technology evolves as quickly as it does.

The debate around these technologies is not however, simply a technological framework debate, as there is great interest in the pedagogical underpinning of such technologies. Traditional learning theories such as behaviourist and cognitivist paradigms are perhaps outdated when applied to mlearning and the digital age. These models, emphasising learned behaviours in response to context specific stimuli and repetition for skill acquisition have their place with modern learners as knowledge is still grounded, but alternative theories of constructivism and connectivism resonate with the digital age in the sense that the knowledge is either created, accessed, or discovered.

This suggests that there may be limitations to many traditional learning theories as argued by Siemens, (2004) when applied to mlearning strategies. The growth in knowledge that has accompanied the rise of the handheld, portable device has not been accompanied by research around these theories, but instead has been aimed at the design of the tools that promote learning (Kearney, et al. 2012). Others argue that much of the mlearning research is simply driven by the technical capabilities of such devices (Naismith, et al. 2004). The examination of pedagogies that underpin mobile learning and the accompanying examination of learner perspectives and experiences therefore are important considerations that facilitate development of mlearning materials and are perhaps not yet fully developed.

Study Background.

The growth of mobile devices with smart functionalities over the past decade has marked the dawn of mobile technology in Higher Education. The rise in use of these devices (global smartphone shipments rose from 304, in 2010 to 1.4 billion in 2019, (Statista, 2020)) both for personal and educational use has revealed changes in the way that learners engage with knowledge.

Contemporary technology now plays a significant role in student learning and influences the delivery of teaching due to the connectability of desktop, laptop, and mobile computers. Whilst technology has had an influence on learning and teaching for the last two to three decades, it is the portability of the mobile device and the ability to connect to the internet without the need for hard-wired or wireless networks that perhaps distinguish how learners engage with knowledge using current technologies and have seen an emergent type of learning known as 'mobile learning'.

Several definitions exist that describe a mobile device. These definitions feature aspects such as portability, connectability and function. Quinn, (2013) perhaps summarises these features in his definition that a mobile device can be defined as any device where it is possible to use with 2 hands whilst standing up or on the move and are single multi-purpose computers with multi-core processors that feature high resolution capabilities and network connectivity. This includes tablets, mini-tablets and smartphones but does not therefore include a laptop as part of the definition. This ability to use a device whilst standing up or on the move offers learners opportunities to engage with knowledge in a time and place that is convenient for them and can extend the advantages of e-learning (electronic learning) systems (Mottiwalla, 2007). Whilst this defines a mobile device, the definition of mobile learning has been less clear, and many deliberations exist, from those who focus upon the portability of the device (Kukulska-Hulme and Shield, 2008), or the learner (Sharples, Taylor and Vavoula, (2005). Palalas, (2011 p.76-77) proposed a definition that best combines these elements and embraces the anytime, anywhere nature of mobile learning.

"Mobile assisted learning can be defined as learning enabled by the mobility of the learner and portability of handheld devices."

The definitions presented above, perhaps contextualise how the mobility of the learner and flexibility of environment has generated much debate around current educational paradigms and their suitability or value to contemporary learning theory (Shippee and Keengwe, (2014). Engagement with e-learning systems within HE establishments such as electronic learning platforms (Blackboard), have enhanced student learning activities in formal University settings and in collaborative environments in non-formal settings. Alexander, et al. (2019) found a virtual learning environment (VLE) supported learning in a group of undergraduate physiotherapy students by providing a supplementary learning option and suggested this had a positive effect on knowledge acquisition. This study found that students reported the VLE resources offered greater autonomy and promoted an efficient, flexible, fast and convenient method. Mobile learning (mlearning) provides both mobility and flexibility opportunities but can also provide the option of self-study, often in environments not traditionally thought of as being learning environments e.g., in-transit, between classes, during break periods etc.

Mottiwalla, (2007) comments that mlearning is unlikely to replace traditional classroom or elearning systems but may work as a supplementary learning method that may complement the more traditional methods. Other authors however, (Kop, 2008), recognize that mobiles and mlearning have the potential to change the nature of the relationship between physical and social space. The ubiquitous nature of mobile technologies has therefore created learning opportunities for students, educators and for educational research into the advantages and disadvantages of this type of learning.

Crompton and Burke, (2018) conducted a systematic review of 72 studies to investigate how research has been conducted into mobile learning. Results showed five themes emerged with 31% of the reviewed studies examining impact of mobile learning on achievement. Student perceptions of learning (29%) and the pedagogy involved in mobile learning (20%) accounted for the other main themes with a lower percentage examining factors affecting uptake (15%) and investigating specific apps or systems (5%). Methodologies involved in these studies showed questionnaires and interviews to be the predominant preferences, accounting for 39% and 11% respectively. Quantitative and mixed methods research however, accounted for a combined 5% of the reviewed studies, perhaps highlighting that research is still at a descriptive rather than theoretical level and that a plausible theory is perhaps lagging behind.

The theoretical educational research has debated the relevance of digital age technologies such as mobile technology and how traditional learning theories may not meet the needs of today's learners (Kop, 2008). Many theories of learning have been proposed over the decades with some tracing their roots to the last decades of the nineteenth century. Some theories have since been super ceded by new knowledge or standards, but generally, there is a wide variety of learning theories today that are comparable and valid in academia (Illeris, 2018). The following section will describe some of the popularised learning theories and how these theories facilitate processes that bring about permanent capacity change both existentially and experientially and their relevance to mobile learning.

Learning Theories.

A theory is defined in the Oxford Dictionary as "a system of ideas that intends to explain something and why or how it occurs" (Oxford English Dictionary, 2007). Therefore, it is logical that a learning theory aims to explain how people learn. These can often be historical constructs that are deemed valid and necessary according to the discourse at that time and help educators understand how learning and education has developed and changed. They help to build new perspectives through a formal process of agreement and disagreement, idea formulation and creative process to spawn new theories (Harasim, 2017). Whilst learning theories developed in the late 20th centuries, their emergence can be traced back thousands of years to the ancient philosophers of Greece such as Aristotle and Plato, whose insights into epistemology and how we view knowledge contributed to the understanding of learning (Kivunja, 2014). These ancient teachings and transfer of knowledge, sometimes referred to as the 'Tabula rasa' or blank slate theory, arguably represent the first recorded existences of knowledge-based communities and perhaps represent the role of discourse and debate for the advancement of knowledge (Harasim, 2017). Knowledge communities are leading thinkers or scientists who represent the state-of-the-art in that discipline who debate, deliberate and define the theory of a discipline and how this is articulated in practice.

With respect to learning theory, four major learning theories have flourished at points in time because of knowledge communities. The following review seeks to give a brief overview of the key features behind some of these learning theories.

Behaviourist Learning Theory

Behaviourist learning theory has its beginnings in Edward Thorndike's late 20th century theory that for children to learn, a manipulation of their learning environment is necessary, which is designed to send stimuli to produce desired learning. More recently, Skinner, (1965), focused more closely on the relationship between environment and behaviour, theorizing those environmental stimuli led to learning connections because of responses to these environmental stimuli. Much of this theory is closely related to that proposed by Pavlov's conditioning theory developed through his work with dogs.

The behaviourist perspective views learning as a measurable construct through observable changes in behaviour (Skinner, 1990, Venezky and Osin 1991, Dunaway, 2011). The emphasis of this theory is that of knowledge adoption through study and memorization, where achievement is the preferred outcome. This theory is typically a rote learning approach to content where the role of the teacher is to be the primary 'source of knowledge' and what content is to be delivered (Brown, 2006). The question of whether this is a process, or a product has been posed by some authors (Duchastel, 1999). The emphasis on knowledge production in this theory is minimal as knowledge is to be 'gained' rather than created, usually through a process of instruction. Gagné proposed a series of nine events to help implement the learning design process by outlining how existing learning will relate to the new information that was to be presented, provide instruction as needed, help integrate knowledge with applied examples, and embed learning through questioning to develop expertise (Gagné, Briggs and Wager, 1992). This 'internalisation' of knowledge views knowledge as external to the learner and thus the goal is to internalize content (Foroughi, 2015). This has led to modern criticism that this theory does not provide an adequate framework in which learners can think and act when presented with an overwhelming world of content provided by a digital world (Bell, 2010). Ally (2009) however, argues that behaviourism is complementary to other more contemporary theories in certain contexts e.g., distance learning. Brown, (2006) supports this view stating that behaviourism is an essential learning theory but is currently not the focus of teaching and learning. Learners still have behaviourist outcomes, particularly in areas of skill development, but the shift in teaching and learning from behaviourist theories perhaps dictates that they are currently in the minority.

Cognitivist Learning Theory.

The principles behind the cognitive learning theory are that internal processes and insights provide key learning strategies and that individuals acquire knowledge though reflection, perception and memory (Gould, 2008). It focuses on how learners think, acquire, recall and retain knowledge.

Cognitive learning theory is often grouped with behaviourism and together, they are often termed 'instructivism' (Porcaro, 2011) although there are some fundamental differences. The differences can be explained as the limitations with behaviourism were recognised in the early 1920s, when an understanding emerged that the influence of the mind in making decisions did not derive purely from external stimulus (Harasim, 2017). Whilst behaviourism was not rejected entirely, the change from external behaviour to internal mind processes was evident. The role that the mind played was influential in the development of this theory as an extension of behaviourism however and developed from the emergence of computer science in the 1940s. As computers were observed to process information, cognitive theorists proposed a theory of the 'mind as a computer' which was able to process knowledge through changes in short-term and long-term memory (Porcaro, 2017). This became known as the Cognitive Information Process (CIP) and thus strove to understand how the mind processed information through a structure consisting of different components. As connectivism will go on to discuss, Siemens, (2004) argues that technology now supports many of these processes including storing, retrieving, transforming and using information.

As the CIP model has briefly shown, the mind is capable of encoding information in many forms such as diagrams, symbols, pathways etc. This relates in some ways to a mental representation of knowledge or 'schema' that may be stored in different forms or ideas. Many examples of 'schema' exist but importantly, they are a part of cognitive learning theory and relate to the mind as a memory structure that contains the extent of our knowledge (Jonassen, Beissner and Yacci, (1993). Schema can also relate to abstract conceptualisation of knowledge e.g., the body possesses two arms and two legs, however these may be different sizes, lengths etc. or they can relate to linked processes such as the assessment of gait i.e., the right leg will follow the left leg, the heel will strike the ground, followed by a mid-stance phase and finally, a toe off phase.

This theory is therefore well suited to rule based or procedural execution but may have limitations in more complex situations such as problem-solving, critical thinking or inference generation (Ertner and Newby, 1993). However, just as with behaviourism, cognitivism methods grant learning control to the teacher which has been criticised as it stifles active engagement of learners and assumes that learning is similar for all individuals (Jonassen, 1991). Much of the cognitivist theory explains that learning is a process of mapping the external world onto the minds of learners (Porcaro, 2011) which feature strongly in traditional teaching methods such as the lecture or instructor-based discussion, hence the learner's primary role is to retain knowledge in a very didactic way (Matheson, 2015). The overarching epistemology of both behaviourism and cognitivism is therefore grounded in objectivism where pre-digested instructor knowledge is then transmitted to learners, focusing primarily on individual learner perspectives.

Elements of cognitivism do also ally closely with another popular learning theory, constructivism, as learners process knowledge objectively but construct their own meaning of reality based on their own perceptions. This area of learning theory is often known as cognitive constructivism and is derived from much of the work of Piaget, (1932). It was, however, the 1970s that saw the new theory of constructivism emerge to complement and challenge the theories of behaviourism and cognitivism (Harisim, 2017). A theory that perhaps moved learners along a continuum of learning where a dualistic approach in which a single correct answer from an established authoritative learning source moved to a relativistic perspective. Perry, (1970) described movement along this perspective as being challenged with thinking that is a level above one's current thinking. A perspective that considered different situations or perspectives may give rise to different answers or opinions from a range of sources, including one's own experiences (Cannon and Boswell, 2016).

Constructivist Learning Theory

Changing the concept of "how we know" gave rise to the resistance of constructivist learning theory and perhaps links to the differences in the epistemology stance of previous instructivist models that were objective and rational (Tippins and Tobin, 1993). This was a radical departure from previous models that did not consider the pluralistic nature of knowledge and focused on stimulus-response, or information processing and held that knowledge was true only if it reflected an independent world. Von Glasersfeld, (2012), argues that constructivism is misunderstood as it claims that reality only exists within the realm of our own experience, rather than that of the independent world. The building of one's own mental structures through new and prior experiences, so that previous instruction and experience support the construction of new knowledge are just some of the elements of constructivist learning theory. Wenger, (1999), describes the mental structures as interacting with the environment in a hands-on, self-directed journey of discovery. Matheson, (2015 p. 38) in agreement with this, states that

"Genuine understanding cannot simply be copied from one brain to another, without the receiving brain engaging in the process."

Constructivist theory therefore proposes that learners construct their own knowledge and understanding through their experiences and the reflections upon these experiences. These new experiences thus require learners to assess previous levels of knowledge and integrate new information to change knowledge beliefs or reject this new information. These experiences form the foundation of and the stimulus for learning (Ladyshewsky, 2006) and perhaps in part, have given rise to such teaching methods as group discussion, reflective journals, and work-based placements (Henry, 1989). The participation in dialogue through such processes as questioning, exploring and engagement thus leads to reassessment of knowledge and acts as a creative vehicle for the construction of knowledge within the learners own experiential world (Harasim 2017).

Consequently, the goal of constructing a coherent understanding of the experiential world presents many approaches and solutions that can be considered desirable, but for the learner, the achievement of the desired goal will be justified by its value. Von Glaserfeld,

(2012) refers to the examples of speed, economy, convention, and "elegance" as justification of achievement with reference to the desired goals. Whilst "elegance" in finding a solution is desirable, the solution may also be inelegant, costly, and time-consuming, however can generate further motivation to seek more satisfactory methods if their approach is seen to be inadequate Von Glaserfeld (2012).

The rise of the Internet has seen a marked change in the ability to access knowledge, information and speedy solutions in this respect. Increasing advances in technology have altered methods of knowledge acquisition and have fostered a more convenient and speedy approach to the accessibility of information (Corbett and Spinello, 2020). Whereas the instructivist theories may profess to "teach" the right solution, constructivism provides a basis upon which learners may develop the freedom in which to operate and discover or construct solutions that lack theoretical foundation but provide the desired goal. The advances in technology, perhaps highlight the limitations of constructivism in this respect, due to the limited context of the micro cultural aspects of learning. The emergence of the internet now allows much broader and diverse cultures of learning via the rise of social networking. This allows learners to experience perspectives from a broader context than their own experiences by engagement within these networks. Where constructivism differs from cognitivism is that it creates meaning for the learner by allowing real-life experiential learning to help scaffold and construct meaning within the boundaries of the individual experiences. Duke, et al. (2013) suggests cognitivism assists the learning from an individual perspective as it aids learning structure and knowledge implementation. The limitations of these theories however, lay in their ability to explain and predict behaviours of learners when engaging with digital systems of learning which are autonomous in nature. Traditional learning theories posit that learning should be presented actively and connected to real-life (Piaget, 1977). The emergence and use of mobile technology in learning arguably challenges these principles due to the learning autonomy, diversity, and connectedness that they offer.

The debate around these technologies has produced great interest in the pedagogical underpinning and challenged many traditional learning theories such as the instructivist theories including behaviourist and cognitivist paradigms as being inferior when applied to learning in the digital age.

These models emphasize learned behaviours in response to context specific stimuli and repetition for skill acquisition have their place with modern learners as knowledge is still grounded, but alternative theories of constructivism and connectivism resonate with the digital age in the sense that the knowledge is either created, accessed, or discovered. Context specific stimuli provided through instructivist and to an extent, constructivist principles have limitations in their inability to prepare learners for an increasingly digitised and globalised world. They are perhaps lacking in their ability to acknowledge the role that digital media and technology play in accessing information from an array of sources in a speedy and convenient manner.

Connectivism Learning Theory

Connectivism was put forward by Siemens, (2004) as an alternative learning theory to behaviourism, cognitivism, and constructivism. Connectivism can be explained as consisting of four ideas. Firstly, that there are connecting nodes meaning that learning is a series of connections. Secondly learning does not necessarily occur solely inside human brains. This is explained in terms of connections between information sources which occur outside of the learner (Siemens, 2006). Thirdly knowledge is not propositional, or fact based, and it is not representational. Downes, (2006) argues that knowledge is pattern of connections and is merely sub-symbolic. Fourthly knowledge is an emergent phenomenon and is not intentional it really emerges when patterns of connections recognised. This may depend upon four interactions between, the context of the location, salience which is a recurrence of the pattern in the network, emergence which is the development of patterns and the persistence of patterns which is the memory aspect.

Connectivism theories differ from the constructivist theories by suggesting that knowledge is not simply stored by the human learner but is accessed via a network of nodes and the interaction and development of these nodes is where knowledge resides (Siemens, 2004). This therefore suggests that knowledge is not propositional, but that knowledge lies in these connections and the interaction between the learners. Constructivist theories, in particular, social constructivist theories contest that knowledge is not simply found or discovered but is generated via social interactions aligned through a process of cognitive growth in which discussions surrounding theory and practical skills are shared (Vygotsky, 1978). These social interactions within a constructivist theory however, view interactions as typically between learners and instructors.

The interactions and engagement within connectivism are viewed from a different standpoint however and grant a level of autonomy to learners that allow knowledge exploration without instructor involvement necessarily. The use of mobile learning devices in this instance acts as a tool for mediation of these social interactions (Kearney, et al. 2012). The ability of mobile devices to offer this level of knowledge exploration autonomy poses an interesting choice for learners and gives opportunity to engage with information in a more flexible manner. Corbett and Spinello, (2020) discuss how connectivism features two critical factors that contribute to learning: locating new information and filtering irrelevant data. Kop and Hill, (2008) however, had previously criticised connectivism as it assumed access to information was ubiquitous and that the ability to memorise knowledge may be subsumed by the ability to find and apply information when and where it is required.

Should new theories of learning such as Connectivism or Navigationism build on older theories or replace those which are deemed inferior? Are the newer theories of learning theories at all or simply methods of learning and tools to find and filter information and knowledge? These theories have emerged since the categorization of learners into brackets such as 'digital natives' (Prensky, 2001) and 'millennial learners' (Howe and Strauss, 2000) and more latterly, digitally wise (Prensky, 2009). Both describe learners who now interact with peers via social connections such as email, Facebook, Twitter, instant messaging and Instagram. The social interaction element of these connections does not necessarily indicate that learning has taken place, or indeed that this type of learning is a common strategy. Park, (2011) alludes to two distinctive forms of distance learning…individualized and socialised as extensions of Moore's Transactional Distance Theory. The presence of dialogue between learners, the structure of learning and the autonomy of learners effectively dictate the 'social' or 'individualised' elements of the learning process. Although this theory is in relation to distance learning using technology mediated communication, the comparison with both social constructivism and connectivism is an interesting topic for debate.

Some studies however have shown that learners still prefer the traditional and familiar styles of learning to the more active types of digital learning. This is partly explained as although 'digital native' learners possess greater levels of 'expertise' when using technologies but lack skill in the application of this knowledge (Oulasvirta, et al. 2010). The implication may be that technological innovations are best implemented when there is a supporting learning theory to inform development. Other explanations have pointed to perceptions of technology and the barriers or facilitators in this process (Davis, 1989, Venkatesh, et al. 2003). The acceptance of technology emerged as a theoretical framework during the 1970s and 80s as a body of work formed that developed several models with the goal of predicting behavioural intention towards technology acceptance. The popularity of personal mobile technology and user acceptance for learning is an interesting area that is currently under researched. Technology acceptance models have existed for many decades and have been applied to organisational technology acceptance rather than personal technology. The following section describes the development and extension of the more popular models and their application to mobile technology acceptance. Their consistency and validity will be described and their contextual importance during the rapid change of portable technology development.

Development of Technology Acceptance Models

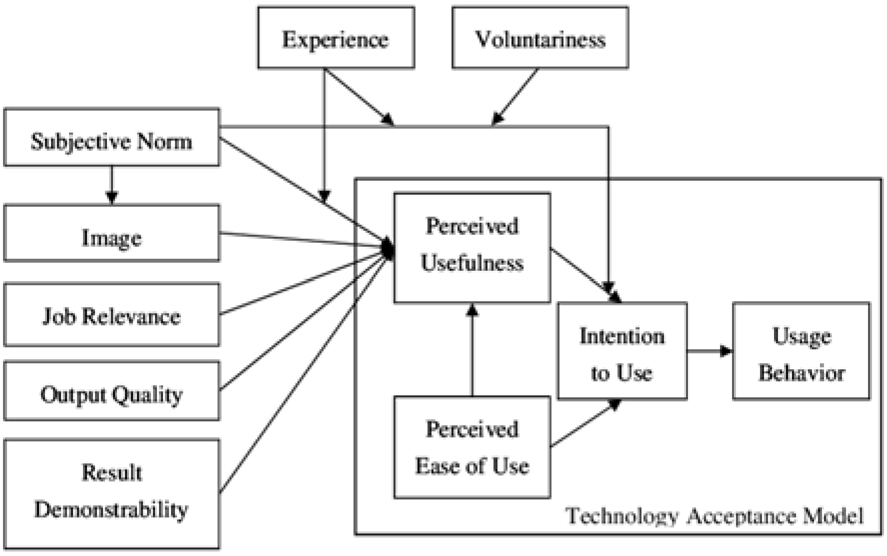
The decision to use technology is always an open question. As the growth of smartphone and digital technology has grown over the previous decade, integration into private, public and educational life has shown similar growth. The rationale behind adoption of technology has been studied for over four decades, from the original theory of reasoned action (TRA), proposed by Ajzen and Fishbein, (1976). The theory was developed to predict and understand behaviours relating to the use of available information. Rather than studying attitudes, this theory sought to understand behaviour intention and beliefs (Ajzen and Fishbein, (1976). The theory of reasoned action was felt by Ajzen to be limited; hence a third dimension was added that considered perceived behavioural control, resulting in the theory of reasoned behaviour (TRB). The individual's intention however, remained at the heart of this revised theory. Behind this intention are the variables of attitude toward the behaviour, perceptions relating to the success of the behaviour and the subjective norms about engagement with this behaviour, (Azjen, 1985). The proposed relationship between these variables was that more confident individuals are more likely to succeed than those lacking confidence. The theory did provide understanding of planned and actual behaviour but was contextually limited in that personality, age, and gender variables were not considered.

Technology Acceptance Model

Davis, (1989) adapted the model with the goal of providing understanding of behaviour prediction when applied to acceptance of technology. The technology acceptance model (TAM) has seen subsequent development and extension since the original 1989 version that focused upon the variables of perceived ease of use and perceived usefulness (Marangunic and Granic, 2014) whilst removing the attitude construct. Behavioural intention was also introduced as a variable due to the relationship with the perceived usefulness as this was strongly suggestive of an intent to use without formation of an attitude, for example toward system characteristics (Davis, 1989). The TAM model became accepted as a leading model, used in most of the research around acceptance and prediction of technology acceptance (Lee, at al. 2003) but was constrained by its inability to identify factors that influenced the perceived usefulness.

Technology Acceptance Model 2

The adapted TAM2 model (schematically depicted below) by Venkatesh and Davis, (2000), sought to address this by introducing the social and cognitive variables of subjective norm (influence of others on decision to use technology), image, (have favourable standing among others), job relevance (applicability of technology), output quality (how well technology performed required task) and result demonstrability (production of desired results/goals).



(Venkatesh and Davis 2000)

Figure 2.1 - Technology Acceptance Model

The variables of 'experience' and 'voluntariness' were also included as factors that affected the subjective norm. Many of these items were developed from prior research (Taylor and Todd, (1995); Moore and Benbasat, (1991; 1992). Further studies by Venkatesh and Davis, (2000) confirmed the relationship that the perceived ease of use was a significant determinant of perceived usefulness. Four studies were reported within the 2000 study and showed the non-significant relationship between subjective norm and both experience and voluntariness, however a significant relationship was established between the output quality and job relevance. Intention to use was also shown to be directly determined by subjective norm, perceived usefulness, and perceived ease of use. The psychometric properties used in all four studies demonstrated Cronbach Alpha coefficients above 0.80 and construct validity strongly supported following direct oblimin rotation, principal component analysis. Cross loadings of 0.30 were factored into this analysis to suppress less meaningful co-efficients. Although these relationships are quoted as significant, and unlikely to be due to chance, many do not show strong relationship between the variables. Usage behaviour, as one of the highest r values, for example, shows a correlation with intention to use of 0.52, which is satisfactory, but not strong.

The TAM is a widely used model in many areas of technology including Web 2.0 technologies such as email (Adams, Nelson, and Todd, 1992) and the World Wide Web (Lederer, et al. 2000), due to both its simplicity and applicability however these are work based studies hence there is an argument for limited external validity. Davis, et al. (1992) argue that whilst the usefulness is the major determinant of usage, the perceived enjoyment serves as a source of internal motivation and will explain further variation beyond this. Moon and Kim, (2001) suggest that intrinsic motivators should be a consideration and define this as when activity is performed for no other reason that processing or performing a task. They proposed an extension to the original TAM which was named 'perceived playfulness' with the intention of adapting the model to the, at that time, emergent World Wide Web and based this extension on intrinsic motivation theory. Davis, (1989) has argued that future models would need to address how variables such as this would affect the ease of use and perceived usefulness.

This model was developed to reflect the change in information access methods with Moon and Kim, (2001) acknowledging that the web is used for both work and pleasure, unlike previous IT systems. Three dimensions were developed as part of the perceived playfulness extension based on the work of Csikszentmihalyi and Deci: concentration, curiosity, and enjoyment. These dimensions are not linked, hence may not reflect total experience (Moon and Kim, 2001). This study tested nine hypotheses based on the relationships within the extended TAM. Cronbach internal consistency coefficients demonstrated values from 0.83 to 0.96 and both discriminant and construct validity were shown to be good and confirmed that the extended TAM demonstrated three uni-dimensional constructs (perceived playfulness, perceived ease of use and perceived usefulness) which were factorially distinct. Hypothesis testing showed attitude toward use of the web is significantly affected by perceptions regarding ease of use, playfulness and perceived usefulness, effectively, supporting the addition of intrinsic motivators to the scale and contextualising the value of these intrinsic motivators. Results from the study also showed a more powerful effect from intrinsic motivation than from extrinsic motivators, which was thought to be an important factor in building positive attitude.

The phrase 'hedonic motivation' is often a term associated with willingness to use behaviour that leads to positive experience or useful behaviour. Since the addition of perceived playfulness to the TAM framework, many further studies have investigated the influence of relevant personal and social variables to account for behavioural intention with technology. Venkatesh, (2000) states that the early perceptions of an individual's use of computer technology is dictated by three 'anchors'; computer self-efficacy/computer anxiety, computer playfulness and perception of external control. The efficacy/anxiety anchor relates to the level of expertise that an individual has developed to use technology; playfulness, represents the internal motivation to use and explore a new system and, finally, the external control represents the level of organisational resource to support a system. These variables are interesting considerations in contemporary learning environments due to the wide availability of external systems available through commercial platforms such as the Apple store or Google Play. These systems represent learning systems with high levels of resource support, whilst incorporating a popular 'gaming' culture that resonates closely with the TAM2 framework of Venkatesh, (2000). He theorised that continuing experience with systems will maintain a strong relationship with development of expertise and external resource support, a feature now widely prevalent with many software developers, however, there would be a diminishing relationship between playfulness and anxiety.

Technology Acceptance Model 3

The anchors from Venkatesh, (2000) were extended from the TAM2 to the TAM3 framework and were investigated by Venkatesh and Bala, (2008) as the new relationships posited in the TAM3 had not been empirically tested in previous tested. Firstly, the role of experience using a system was proposed to influence or moderate the perceived ease of use which in turn would be important in forming perceptions regarding usefulness. The suggestion was that increased experience would show a stronger relationship with perceived ease of use and perceived usefulness. Secondly, the role of experience would moderate inhibited use of technology as increased experience with technology and information systems would help users to gauge accurate time frames and associated efforts for task completion. More accurate perceptions of effort would therefore relate to increased experience and lower levels of computer anxiety. Thirdly, experience would moderate perceived ease of use as procedural knowledge increases, hence the ease of use of technology is considered less but behavioural habits have formed. Four sites were selected from varying professional backgrounds: financial, accounting, investment banking and manufacturing. Each site introduced a new IT system to the firms and relevant on-site training was provided, ranging from 4 hours to 2 days. TAM3 questionnaires were completed online after initial training and at 1 month and 3 months using paper-based questionnaires.

The results from Venkatesh and Bala, (2008) showed similar levels of construct validity and internal consistency to the TAM and TAM2 frameworks but showed that experience plays a major role in IT adoption and increased experience increases the perceived ease of use and perceived usefulness. It also showed that the perceived ease of use was not an influencing factor in the perceived usefulness and vice versa. A system therefore may be easy to use but may not necessarily be useful, however experience played an important role as this may establish links between these variables.

The TAM3 framework consistently showed across three data collection points, self-efficacy, perceived external control, computer playfulness and computer anxiety significantly predicted perceived ease of use, however, enjoyment was not initially significant (after initial training), but significantly predicted this at one- and three-months post-training with the information systems used. The significance of this paper goes beyond the importance of developing effective interventions to enhance IT adoption in a wide variety of environments, it clearly signposts how experience, enjoyment and expertise relate to usefulness of a system. For educational use, both for learners and teachers, this is a prime consideration for adoption of technology. Systems and resources therefore should reflect these variables if they are to be successful, however, the TAM3 model may not predict acceptance when technology is a personal rather than imposed choice, nor consider teacher perceptions and beliefs around teaching and learning (Teo and Zhou, 2017).

Unified Theory of Acceptance and Use of Technology Model

Several other models do exist that explore theories of acceptance such as innovation diffusion theory, (Rogers, 1995), motivational model (Davis, et al. 1992), social cognitive theory, (Bandura, 1986), model of PC utilisation (Thompson, et al. 1991), and model of acceptance with peer support (Sykes, et al. 2009). Venkatesh, et al. (2003) proposed an integrated model of these theories with the unified theory of acceptance and use of technology (UTAUT).

An empirical study was performed across four organisations to predict user acceptance of new technology introduced to the workplace. The UTAUT questionnaire was created, developed and validated from eight commonly used questionnaires and used at three data collection points (after training, at 1 month and 3 months post training) and found four determinants of behaviour and four moderators. The variables of performance expectancy, effort expectancy, social influence and facilitating conditions were shown to be direct determinants of behavioural intention and use behaviour. Venkatesh, et al. (2003) emphasise however that most of these key relationships are moderated by age, gender, experience, and voluntariness of use, commenting that there is very little research around the influence of age and little around gender. The patterns arising from the results of this study suggest that effects of performance expectancy on behavioural intention was stronger for younger and male subjects, whereas effort expectancy was stronger for females, older workers, and those with less experience of systems. The significance of this study was that it had the ability to explain around 70% of the variance of intent to use technology and offered a tool to assess the introduction of new technology across a range of business contexts. The study also noted that social influence was not a significant factor in voluntary contexts. The original model has since been extended to UTAUT 2 (Venkatesh, Thong and Xu 2012) which embraced the voluntary contexts by applying the constructs of hedonic motivation, price value and experience/habit.

A number of survey-based studies have used the TAM and UTAUT questionnaires to explore various influences of technology upon users. A feature of this research is the exploration of organisationally introduced technology rather than user-selected technology. Whilst these questionnaires serve as useful barometers of acceptance, they can be limited in context as many digital learners now are able to self-select from a wide range of personal technologies.

Survey Research Studies.

Several studies around the digital literacy of users have been performed. Many of these have used a survey design approach to investigate the outcomes, which include predictive strength of attributes of digital natives (Sorgo, et al. 2017), demographic attributes of Twitter users and the perceived digital divide (Blank, 2017), acceptance of technology in classrooms (Gu, Zhu and Guo, 2013) and findings on Facebook in HE (Roblyer, 2010). The popularity of digital literacy as a term within technology research has attracted more recent interest and has been predicted to continue following Cassidy, et al. (2019) findings who surveyed 25 global literacy leaders from across the globe using a 30-item 'hot or not' questionnaire. A purposive sampling approach asked participants to rank topics as 'hot' or 'cold' and reported these as percentiles where a 100% consensus was extremely hot, a 75% consensus was very hot, and 50% consensus classed as hot. Below 50% was classified as a cold topic. The hottest topics were digital literacy and new literacies plus media literacy. The discussion points of the article centred on students constructing their literacy identity through digital literacy with this linking to confidence and development of individuals and peer-group epistemic authority. Whilst this is a purposive sample, it demonstrates a homogenous global sample as the questionnaire developed by literacy leaders and transferability is largely limited to North America as only a single respondent was outside North America. Little information on face or construct validity of the survey questionnaire is provided and responses only offer dichotomous responses. The discussion around students constructing digital identities, however, has possibly arisen due to other survey type research.

Surveys are and have been a common method of investigating various aspects around technology acceptance, digital literacy, and demographics of technology users, however, lacks the ability to explain why or how users behave as stated. Additionally, cross sectional research such as simple and longitudinal questionnaires only reveal a snapshot of behaviours at that point in time and hence whilst giving valid results, the findings can become outdated (Bowling, 2014). The development of the TAM models however has continued to feature within much of the survey research. Gu, Zhu, and Guo, (2013) adapted the TAM models of Venkatesh, (2003) and Venkatesh and Davis, (2000) and developed a 27-item questionnaire that aimed to explore the acceptance of technology within the classroom. The questionnaire explored four constructs of technology acceptance and was distributed to 2161 students plus 249 teachers across 19 districts around the Shanghai region. Within these districts, five schools per district were selected and 100 participants were recruited (90 students plus 10 teachers) using stratified random sampling. The questionnaire explored the constructs of outcome expectancy, task-technology fit, social influence and personal factors and was measured using a 7-point Likert Scale. Cronbach's Alpha, paired t-tests and Post-hoc ANOVAs were used for measures of internal consistency and for differences between the frequency of use at home vs school. Factor analysis was used to identify and load the four constructs. The results of the study demonstrated that the most powerful predictor of technology acceptance was the personal factor for in-class usage. The study also demonstrated some habits occurring in males and females, and between teachers and students. Students were shown to have a higher self-efficiency than teachers, based on having more access to IT at home. This may also however, simply be due to students having more free time to dedicate to IT than teachers as outlined by the net generation description of Oblinger et al. (2005).

Gu, Zhu, and Guo, (2013) also report that boys were more influenced socially by IT than girls, particularly with home-use. This was discussed and a theory postulated that the expectations within school were not being met; hence more engagement was seen at home to meet this expectation. The results of the outcome expectancy construct supported the authors claim with reference to this and the study gave some confirmation that the early adopters identified within the questionnaire show the characteristics of digital natives as outlined by Prensky, (2001). The social influence construct was identified as an important consideration for technology acceptance within class, but also, interestingly can be seen as students demonstrating anxiety in being 'left behind' which may also help to explain the increased home engagement. This study demonstrates however, how the TAM questionnaire can be adapted and developed to fit a more focused population where the use of technology is in part enforced through the school systems, but also offers personal choice in technology through home engagement. Gu, Zhu, and Guo, (2013) concluded with a recommendation that interviews would help to explain some of the questionnaire findings in greater detail.

Kuek and Hakkennes, (2019) also used the TAM model as a basis to investigate healthcare staff digital literacy and their attitudes towards IT systems. The questionnaire was distributed using both online and paper copy methods and adapted the TAM and UTAUT as the basis for the questionnaire. Rather than using all eight domains of the UTAUT, Kuek and Hakkennes, (2019) used only four, arguing that the TAM model measured two of the domains and the remaining two were not appropriate as they were investigating attitudes toward a new system (implementation of a new health records system). The study results report a disappointing 6% questionnaire return rate (407 respondents) and demonstrate that staff hold positive values about value of technology and hold positive attitudes towards Information Systems. Staff aged 50+ however, showed significant differences in domains of TAM and UTAUT in areas of anxiety about using technology, attitudes towards working with technology, social influence and facilitating conditions. Also, some significant differences were noted between clinical and non-clinical staff with non-clinical staff aged under 50 were seen to hold the most positive attitudes towards technology.

The results do demonstrate a small response bias to the questionnaire as 90% of completed questionnaires were returned online compared to 10% who returned a paper copy. An appropriate sample size was recruited however, based on a power calculation which required 364 to complete the questionnaire. Some of the conclusions agree with Bhatt and MacKenzie, (2019) around the concept of epistemic authority. This study does serve to illustrate once again, how a survey was developed and adapted from the TAM and UTAUT models, but it must be remembered as with other TAM and UTAUT studies, this was investigated where technology was an institutional adoption rather than a personal choice.

Uses of Social Media for Learning.

Mobile technology research has also embraced aspects of web 2.0 technology and the use of social media for learning has been investigated by several authors. The dominant methods used again feature survey-based research and qualitative interviews, which help to explain the ways how subjects engaged and why they engaged with mobile technology.

Roblyer, et al. (2010) investigated the uses of Facebook (Fb) amongst staff and students within a HE institution and compared uses and perceptions of social network services between these groups. Using an online survey questionnaire, Roblyer recruited via convenience sampling, 120 students and 62 staff from the HE faculty. A 9-item instrument was used to collect responses to uses and perceptions of Fb and analysed appropriately for between group and within group differences using Mann-Whitney and Wilcoxon Signed Rank tests. Results showed that 95% of students had a Fb account compared to 73% of staff. Students were much more likely to check Fb rather than email. No significant differences were shown in how often groups checked their Fb account per day. Staff were more likely to check email than Fb however. Fb was also less commonly used for instructional purposes and that social uses were much more common possibly due to differences in perceptions for instruction. Students demonstrated they were more likely to agree that Fb is a convenient learning environment however, staff were far less likely. Roblyer, et al. (2010) also report evidence of an exodus towards Twitter although no explanation is proposed. Unlike Kuek and Hakkennes, (2019), Sobaih, et al. (2016) this study gives no details of how the questionnaire was developed or how reliability and construct validity was established. There is also the possibility of a non-response bias amongst staff members who did not hold Fb accounts, therefore the 73% staff Fb account holders may be an inflated percentage of the whole staff population within the HE institution. This study helps demonstrate the uptake of social media platforms such as Fb as both convenient and helps to establish the age demographic for use. The higher uptake amongst a younger HE student population may indicate that the ubiquitous nature of mobile technology could be a useful predictor of future use.

Sobaih, et al. (2016) investigated social media in Higher Education in developing countries using a pre-tested questionnaire followed by 27 semi-structured interviews. The questionnaire was developed and adapted from the TAM2 model of Davis (2012) and consisted of five sections. A convenience sample was used and 190 respondents (84 teaching assistants, 86 professors and 20 admin staff) competed the questionnaire which showed significant differences in perceived values and uses of social media across 4 main factors (teaching and learning, student support, community building and connection value, program marketing and promotion value). Given the sampling discrepancies and nature of occupation and higher mean age between the administrator group and the other groups, it is perhaps unsurprising that this group were less likely to use social media than the other groups. The authors also perform metric data analysis on non-parametric data; hence findings were interpreted with these limitations in mind.

No details were included detailing how interviewees were selected, however the authors reported 11 barriers from the qualitative content analysis. These included issues of privacy and security, time commitment required, digital divides such as trust in the technology, age, institutional support and awareness of how to use technology. This study does lacks transparency when reporting the qualitative study as few details are given regarding interview process, reflexivity or data verification procedures when developing codes and findings. Although this was performed in a developing country, the resolution of barriers is not simply constrained to these as similar barriers are quoted by other authors (Bhatt and McKenzie, 2019, Cassidy, 2019). The study perhaps also raises the question that, given the barriers stated above, simply using social media is not indicative of digital literacy.

Sorgo, et al. (2017) investigated digital literacy amongst a group of 299 ‘digital natives’ across six European institutions. The study aimed to consider the predictive strength of attributes in ‘digital natives’ as predictors of their IT literacy in Higher Education. The attributes included their information and communication technologies (ICT) ownership, ICT experiences, internet confidence and ICT rich university courses. Participants were recruited using convenience sampling and data was collected using an online survey questionnaire.

Data collected included responses to author developed item tests such as the IL Test (a 40-item multiple choice test), (Boh Podgornik, et al. 2016) ICT experiences scale (16 item list of ICT applications), ICT ownership scale (Smartphone, laptop/notebook PC, desktop PC and tablet), Internet confidence scale (10Q Likert scale (1-5) with a range of scores from 10-50) and a descriptive ICT rich courses scale.

Sorgo, et al. (2017) reported that the highest scores were obtained in applications performed regularly e.g., internet search, social networks, videos, communication. The lowest scores were obtained in apps where specialist knowledge required and were often skipped by majority of students. The ICT ownership revealed that all participants own at least 1 device and that 75% use smartphones and 71% use PCs more than once per day. The figures around tablets and desktops reveal that 67% do not use tablets, 20% use desktops whereas 33% never use desktops. Pearson's Correlations show a negative correlation ($r=-0.469$), $p>0.001$) between PCs and desktops i.e., portables (laptops) have essentially replaced desktops. The use of desktops was reported more widely for programming games ($r=0.225$ $p>0.001$) and web page design ($r=0,171$ $p>0.001$) requiring more computer power but this does not necessarily indicate better information literacy skills. There was also some weak evidence that the top smartphone users are also tablet users ($r=0.131$ $p>0.05$). Interestingly, the strongest predictor of information literacy was the non-use of a tablet which correlated negatively with information literacy ($r=-0.191$, $p>0.001$). The inferences made from this study are that tablets were not used for study purposes but were used for personal and recreational activities such as media consumption etc. and act as a distraction from study. The authors also conclude that ownership of ICT devices does not overall, affect information literacy and digital natives are not necessarily information literate. Whilst these findings shed light on the literacy of the net generation, this study was performed on a sample of Science and Technology students and is not generalisable beyond this context. Whilst the survey instruments were piloted on smaller groups and were validated, the calculated mean scores are from Likert scales which are ordinal in nature (Field, 2015) and therefore median scores would be more appropriate given the level of data. Lastly, whilst the correlations are significant, the R-values demonstrate weak correlations of below 0.3 and should therefore not be interpreted as strong conclusions.

Predictors for use of Mobile Technology.

Whilst the conclusions from Sorgo, (2017) may not demonstrate statistical rigour, they do give attention to the information literacy of users both within a student and staff population. The findings that number of devices owned by participants were not a significant influence and that digital natives are not necessarily information literate merits further investigation. Blank, (2017) conducted a much larger study to examine the digital divide within a population of social media platform users to explore the implications for social research. Blank, (2017) recruited 2000 UK platform users (including Twitter, Facebook, LinkedIn, Pinterest, Instagram and Google+) users aged 14 and above to complete a telephone survey, followed by face-to-face interview. The telephone survey consisted of 43-item 6-point Likert Scale rating users (ranging from 1-6, giving a theoretical composite score of between 43 and 215). Odds-ratios from logistic regression analysis were used to predict the profile of Twitter users and results showed that Twitter users were likely to be a younger age group (18-24) and were likely to be a student population (18%) or in possession of a degree.

In both the UK and USA, users were more likely to be younger, better educated, students, employed, single and wealthier and 10% more likely to be white. Results also report that users were more likely to be younger than other SNS users (e.g., Facebook). Age, income, and life stage were significant predictors of Twitter (and for Facebook and Pinterest) usage with Twitter users more likely to participate in Internet activity than non-users. Blank, (2017) also report that Twitter users are more likely to engage in a wider range of activities than non-users with an average of 30 activities compared to 20 activities for non-users. The Oxford Internet Survey (Dutton et al. 2013) show statistically significant differences between Twitter and non-Twitter users in 48 attitude variables. The significance of this is to consider the influence of SNS and Twitter upon digital literacy of users and perhaps the influence of Twitter, given the larger student engagement, upon learning rather than social contexts. The age and income of users are the best predictors of Twitter use with education playing less of an impact, which may be worthy of enquiry in a student cohort studying a similar degree such as Physiotherapy. Other platforms such as Instagram and Google+ showed no demographic characteristics that predict behaviour use, whereas income was the best predictor of use for LinkedIn.

It must however also be considered that Twitter users are subset of internet users and further subset of the digital population hence are an unrepresentative and potentially biased sample, hence inferences drawn from the study are not generalisable, or at best represent a snapshot of opinions. It must be remembered that protected tweets result in only part of Twitter user's data being available and access to a representative collection of tweets for this study would prove difficult. Blank, (2017) however do provide a convincing argument for Twitter as a source of information and opinions for users to access and this study does give a better understanding of the profile for Twitter users. The subject of 'influencers' may also be contextualised through reporting of figures in this paper which state that the top 1%

of Twitter users send 20% of all tweets and that 15% of all Twitter users send 85% of all tweets. The proportion of “lurkers” (users who access material but who do not actually ‘tweet’) was estimated to be 44%. This statistic is an important consideration for a sizeable proportion of behaviours amongst Twitter users as it gives an insight into the use as a potential information source rather than as a vehicle for dialogue and debate.

Thus, there is much research around user readiness towards the adoption of technology. As technology however became increasingly portable and networked, users were offered choice with respect to learning environments. Affordability and availability began to dictate that mobile devices were pervasive in everyday life, hence this evolving landscape attracted users to accept technology for many leisure, communication, and educational interactions (Baran, 2014), hence a need arose to understand user perceptions in this new context (Lu, et al. 2016). Rapid technological developments, combined with the rise of the "digital native" generation (Prensky, 2001) led to suggestions of a 'digital gap' in these new contexts however, between teachers and students (Gu, Zhu and Guo, 2013). Motiwalla, (2007) and Park, (2011) outlined the challenges in the adoption of mobile technology and the need for assessments of readiness to be developed (Corbeil and Valdes-Corbeil, 2007). Studies investigating technology acceptance have seen the emergence of the extended TAM (Sarrab, Al-Shibli and Badursha, (2016), Prieto, Miguelanez and Garcia-Penalvo, (2016) and UTAUT (Ibrahim, (2017), Iqbal and Qureshi, (2012) Lu, et al. (2016)) as the prominent evaluation models. Many of these studies reported mixed results around mediating effects of social norms, age and gender. Wang, Wu and Wang, (2009), Lu, et al. (2009) report age difference moderates social influence, Lowenthal, (2010) reports no mediating effect of age or gender. Most of the studies, however, consider perceptions from the student end user perspective however and there have been many calls for perceptions of teachers to be considered (Uzunboylu and Ozdamli, (2011), Baran, (2014), Uzunboylu and Tugun, (2016)), plus the development of theoretical models of mobile learning.

Many conceptual frameworks for mlearning design and evaluation exist that range from multi-level models (Parsons, Ryu and Cranshaw, (2007), Vavoula and Sharples, (2009), whilst other authors have investigated the social aspects of learning (Pachler, Cook and Bachmair, 2010). Koole's (2009) FRAME model (Figure 1) considers factors from 3 context, namely, the learner, the social aspect, and the device aspect. The model is represented by 3 overlapping circles to produce areas of commonality; however, intersecting sections can be confusing at best and contrived at worst.

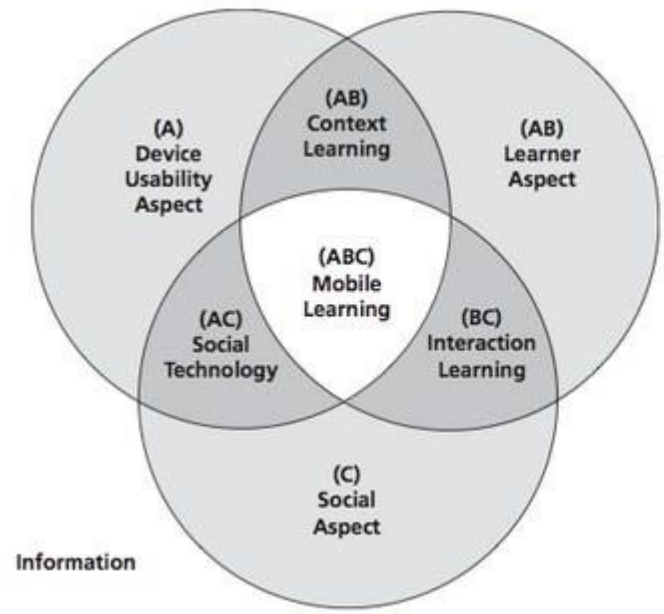


Figure 2.2 FRAME Model, (Koole 2009)

Kearney, et al. (2012) built on this concept with an iterative process to produce the conceptual (now iPAC) framework Burden and Kearney, (2017) consisting of three constructs (personalisation, authenticity and collaboration) and, initially, six sub-constructs (outer ring) but avoided overlapping areas and considered the boundaries of time and space within formal learning (Figure 2). The construct of authenticity remains but has been developed and consists of three subconstructs (setting, task, and tool) rather than the originally developed two sub-constructs. This framework has been applied to explore levels of authenticity, collaboration, and personalisation in 46 teacher educators using an online survey (Burden and Kearney, 2017). Findings from this study suggest that teacher educators across two countries (UK and Australia) were cautiously exploiting the potential of mobile technology to mediate online collaboration. Self-perceptions of authenticity with generative tasks were high, however the construct of personalisation and online collaborations through conversation was weaker.

Although the sample size was small and the self-selected nature of the sample may demonstrate a degree of response bias, this framework does serve as a useful theoretical concept by which individual learners may be analysed. Learner generated rather than teacher generated resources may be a useful comparison when considering the constructs of personalisation and online collaboration.

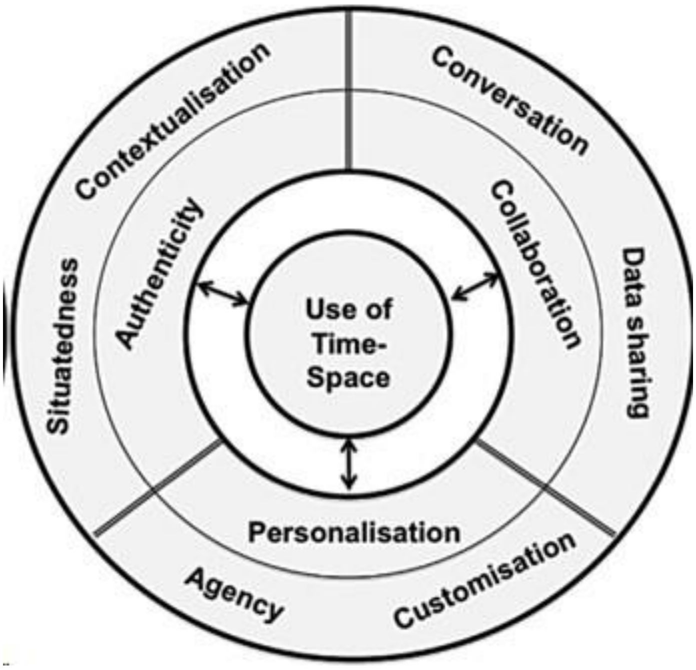


Figure 2.3 Conceptual Framework for mlearning, (Kearney, et al. 2012)

Many studies have linked teaching and learning conceptions of teachers to their preferred educational beliefs (Ertmer, 2005, Ertmer, et al. 2012, Becker and Riel, 2000) and have shown teachers with traditional instructivist approaches to be less conductive towards the use of technology. Conversely, those with more constructivist approaches demonstrate a more conductive approach to the use of technology and embrace student-centred technology methods (Hermans, et al. 2008) showing a positive effect of classroom computer use.

Pedagogical change is often a slow, challenging, and difficult process. Examples exist within the research literature where technologies are adopted and compared against traditional models. Ultimately, these result in no significant shifts in pedagogy and in fact can result in a return to more behaviourist models, e.g., podcasts are useful to refer to for content driven material but can foster an approach in keeping with a repetition and practice approach but does not encourage higher level thinking skills (Herrington and Herrington, 2007). Theories around this have commented that often, lecturers that engage with the newer technologies are technologically less competent than the learners and still coming to terms with its capabilities, hence content driven material is delivered in a more traditional and pedagogically regressive manner.

Reeves, (2005) has previously argued that four strategies should be considered in educational research using technology. These strategies are chiefly aimed at minimizing the reliance upon established learning theories and pedagogies and exploring the potential to develop new pedagogical paradigms using mobile technology. These strategies are…collaborative research methodologies, new support strategies, new reward strategies and a change in dissemination methods when communicating research to consumers.

Online communities of practice (COPs) are an emerging research method that create collaborations between interested learners and are hypothesized to play a dynamic role in how associated learners' process content components of the relevant theoretical area. Wenger, et al. (2002 p.4) defined a COP as

"Groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis."

COPs are firmly established as part of knowledge exchange processes in business as Zhang and Watts, (2004) comment how online COPs offer an additional theoretical link between knowledge and computer mediated communications. These can be useful for providing context particularly after activities involving instructional learning e.g., skills-based learning within educational health-care settings.

The integration of technological stewards as described by Wenger, et al. (2009) can act as a support strategy for COPs particularly when COPs are sustained. The technological stewards are part of a collaborative COP that additionally involves student learners and course lecturers. The introduction therefore of mlearning COPs may help to foster a change from lecturer-directed and lecturer generated content towards a student-centred and student generated content. The significance of this as a method for delivering knowledge is that it represents a shift from a method of teaching and learning from a pedagogical model to an andragogical model and perhaps may in part, explain why new learning theories should be encouraged, examined, and evaluated.

Brandt and Rice (2012) (in Berge, and Muilenburg, (2013)) describe the use of tablet-based mobile-medicine as a collaborative learning paradigm that is affordable, engenders mobile and is self-directed. They describe a simple protocol allowing consultations between medical practitioners using mobile devices such as the iPad. Physicians or health-care practitioners in separate locations can collaborate with each other when patients present for a range of health care scenarios. These may include routine consultation, a bedside consultation, during an emergency scenario e.g., scene of accident, ambulance en route to acute setting or at home. The important point of this example is that traditional learning and collaboration may be augmented using mobile technologies to bring about changes in models of teaching and learning. Within medical and allied health training, the predominant models of learning are social constructivism and problem-based learning (Brandt and Rice, 2013). The social constructivist model is more prominent in the early curricula and problem-based learning, later in the curricula as decision making skills develop and clinical based scenarios help to integrate these with clinical practice.

Within physiotherapy pre-registration education, studies exist that explore aspects of technology e.g., use of wikis (Rowe 2012) student generated content for assessment (Coulson and Frawley, 2017) or use of VLE for learning (Alexander et al. 2019). These studies have explored opinions through surveys, whereas others have explored student physiotherapy opinions of videography using focus groups (Hurst 2016) or teacher opinions of flipped classrooms (Roe 2019). Franz and Rowe (2013) argue that careful integration of technology to compliment more traditional teaching methods will enhance physiotherapy education through facilitation of discussion and interaction to bring about higher cognitive functioning. This is a valid argument that is underpinned with the social constructivist learning theory but is applied to clinical practice and addresses technology in general rather than specifically addressing mobile-mediated learning. Thus, an emergent argument exists to explore opinions and ultimately, the influence of this as a specific technology upon physiotherapy student learning.

Mobile Learning in Physiotherapy.

Search Strategy

The literature around mobile learning in physiotherapy was important as it helped to frame the research question and inform the approach to the methodology. Whilst the existing evidence base had limitations in the context of studies around the influence of mobile mediated learning within physiotherapy, it was important to identify this, along with emergent studies with relevance to the profession.

Searches were performed using core bibliographic databases: CINAHL via EBSCO, MEDLINE, AMED, Scopus plus the commercial database, Google Scholar. Details of the search strategy are outlined in Appendix D. The literature presented below is framed as a narrative literature review rather than a systematic review due to the rapid changes that technology features and hence a changing body of literature.

Within the physiotherapy profession, the specific literature examining the influences of learning mediated by mobile focusses strongly upon resources that have been generated by sources other than the learner themselves. Many studies examine the effects that provided resources have upon student learning and use quantitative type data for the evaluation and outcomes. These include resources generated by staff within university environments or through provided links to recommended resources. The emphasis and selection of resources is thus partially dictated not by the learner, but by staff. The freedom of the learner to explore or develop their own choice of resources is an uncontrolled and unacknowledged variable in many of these studies. Olivier, et al. (2020) conducted a scoping review of 52 studies that considered technology in pre-registration physiotherapy and occupational therapy education. Much of this literature was from Australia and the United States with only five studies from the UK meeting the eligibility criteria. These, however, explored the influence of recommended academic resources and did not explore how mobile mediated learning through self-generated resources support professional skill development.

Similarly, Macznik, Ribeiro and Baxter (2015) report in their systematic review, around the technology use in physiotherapy teaching and learning, that from 22 included studies, online technologies (websites and discussion boards) offer many benefits for physiotherapy teaching and learning. These include incorporation of quality of content, flexibility of access and support of lifelong learning. The review also highlights mixed results in skill acquisition with some showing benefits and other studies showing no difference. The review comments that previous reviews have focused on dental, medical, and nursing education and highlights the lack of reviews that focus on online resources physiotherapy education. This review however did not report the influence that mobile technologies such as smartphone or tablet use have on physiotherapy teaching and learning. The review however does report minimal barriers for the use of online technologies, though as many focus on resources provided through university platforms and online virtual environments, this is unsurprising. The reviews of Olivier, et al, (2020) and Macznik, Ribeiro and Baxter (2015) represent the only research relating to technology use within physiotherapy literature, however there are other studies who have explored the use of various types of technology.

Fernandez-Lao et al (2016) explored the examination results of a musculoskeletal module to evaluate the effects of pre-recorded video lectures/ppt slides, directed YouTube videos, podcasts and elearning course plus scientific papers a week ahead of sessions. Roe et al. (2019) explored the effects on exam performance of a mobile app (experimental group only) plus traditional learning materials (both groups) to evaluate the development of palpation and ultrasound imaging skills to supplement the traditional learning of physiotherapy students. Both studies demonstrated no significant differences in exam scores or theoretical knowledge but concluded that higher scores were shown for probe positioning and patient positioning in the experimental group. Roe et al. (2019) concluded that a flipped classroom approach in physiotherapy education resulted in improved student performances in this professional programme, when compared with conventional teaching. Both studies demonstrated small sample sizes (n=49 and n=54 respectively), hence generalisability is limited and a historically controlled, prospective, cohort study further limits the findings of the Roe study. The higher scores seen for patient positioning in the experimental group, however, do hint at the influence that mobile apps may have in aspects of clinical skill development.

Alexander et al. (2019) explored the knowledge acquisition of entry level UK (London) based physiotherapy students using a mixed methods approach, consisting of a survey, followed by three focus groups. They purposively recruited 79 BSc and MSc Physiotherapy students who were enrolled on a movement and exercise module with access to technology enhanced learning resources such as PowerPoint slides, quizzes, screencasts, journal articles, lecture recordings, videos, past papers, and condition-specific exercises. Participants were asked to rate their satisfaction of the resources using a 5-point Likert scale (strongly agree to strongly disagree) based on a range of questions. Results reported a 97.6% agreement/satisfaction with resources with 76% agreement that the resources were engaging. The participants had a 97% agreement that the resources helped with both practical and written exams and 100% agreed that the resources were useful for aiding their knowledge of exercise medicine.

The survey also noted a significant improvement in module mark from the previous cohort (67 to 75% overall) demonstrating an improvement from 72.9 to 81.8% for the practical element and an improvement from 67.6% to 70.8% for the written component. The qualitative aspect of this study aimed to show an understanding of these results and thus, three focus groups were conducted using 14 participants who completed the original survey. The focus groups conducted were of varying duration (84 mins, 61 mins and 97 mins) and were analysed with an inductive approach. Five higher order themes emerged from the analysis, including content quality, interaction, and accessibility, learning goal alignment, satisfaction with resources and suggestions for the future. Results demonstrated that having TEL resources allowed a 'trust' that resources were correct. The lectures summarised the main points, whereas quizzes were 'different' to usual resources. Videos were perceived to be better and easier for dyslexic students as they accommodate lots of learning ‘styles’ and resources were all in one place. Interaction and accessibility theme reported that TEL resources were easy to access and navigate however there were some compatibility issues as some resources didn't work. A greater level of autonomy over learning access at home or during commutes were reported by participants to be advantageous. Exam papers were perceived to be helpful for written exams, whereas YouTube was helpful for practical exams. Participants reported that it was useful to link resources to placement preparation and that it was not as time consuming to access resources and saves having to 'hunt' for resources. Quizzes and videos were cited to be the most popular resources but there was generally a positivity about all resources in general. Suggestions included the need for a clear link between resources and learning objectives e.g., group by topic rather than lecture/practical etc.

There are several conclusions raised by this study which are worthy of consideration. Firstly, the use of video-based resources for clinical and practical skills development is a key point that participants report as being very helpful. These were cited as being accessed via YouTube, which is a public social media video platform with a vast library of video content from hugely divergent areas. Secondly, the participants viewed the greater level of autonomy to be advantageous, which may suggest either that, learners value the freedom to explore resources or that they value the ability to access resources at a place and time that are convenient to them. The vast content library of YouTube contains many unregulated and non-peer reviewed videos; hence learners have opportunities to explore this platform if they choose. Thirdly, the compatibility issues that were reported with some resources raise the question of format and whether the 'incompatibility' resides with the resources themselves or perhaps that solutions exist, however the ability to solve these incompatibilities and find a solution was not well developed in the participants. Lastly, these points collectively raise the question about convenience and availability. The time saving effect of not having to 'hunt' for resources and the resources being in one place, coupled with the insurance that these resources are provided by academic staff and thus have what Bhatt and MacKenzie (2019) refer to as 'epistemic authority' have competing interests. They provide certainty to learners about the content and assessment requirements; however, the provision of a more convenience-based model is perhaps at the detriment of curiosity and literacy in that these skills are not required as much to locate resources required for learning and perhaps do not encourage learners to go beyond their usual borders of learning.

The clear preference reported for video-based resources for practical skills development in the Alexander study chimes with Hurst (2016), who explored video podcasting to enhance the learning of clinical skills amongst undergraduate and pre-registration physiotherapy students. This qualitative study explored the experiences of using video podcasting to develop the clinical skills of 31 BSc and MSc Physiotherapy students. Semi-structure interviews collected student opinions that were analysed using a thematic analysis framework and reported that students valued the versatility of vodcasts and provide help when revising for skills development exams and allow for repeated practice of skills. Six themes emerged from the analysis, revision, repetition, refinement of skills, confirmation, authenticity and placement benefits. These studies agree that video-based approaches to learning foster a repetition-based approach to skill acquisition and provide the epistemic authority that Bhatt and MacKenzie (2019) allude to in their study. Student physiotherapists value the reassurance of these resources as they provide a skill template that may be copied or mimicked in order to navigate practical based or placement assessments, very much in keeping with the instructivist approach to learning.

Specific literature within physiotherapy has also reported contrasting results from studies that use digital technology. McAllister (2014) explored the use of instructor produced YouTube videos using a pilot survey to supplement the manual skills of a cohort of Australian MSc Occupational Therapy (OT) students. He explored how 43 OT students enrolled on a kinesiology module perceived the value of using instructor produced manual skills videos using an online satisfaction questionnaire that measured satisfaction on a 5-point Likert scale. Skills videos were produced using a smartphone (Apple iPhone 4S) and were taken from in-class demonstrations of manual muscle testing and range of motion techniques such as goniometry. The questionnaire was distributed during the final week of a 6-week trial and demonstrated that students viewed the videos approximately 60 ties per student (2573 total views). Mean scores from the survey questionnaire report scores ranging from 4.24 to 4.73 (agree to strongly agree).

Conclusions suggested that the videos appreciated the ability to replay the videos continuously and the close scrutiny afforded by these was helpful to their learning. Both video and audio portions were found to be helpful as the audio also afforded better appreciation and use of anatomical landmark terminology. Whilst the use of mean scores rather than median scores perhaps ‘inflate’ the satisfaction findings from this study, there is strong evidence to suggest that students were supportive of this resource due to increased competence and confidence. Whilst the videos were watched primarily using a laptop, this study was conducted when the emergence of smartphones was less significant than at present but does help contextualise the value of video for clinical skills development.

Weeks and Horan (2013) also explored the influence of video-based activity on placement preparation in a cohort of Australian physiotherapy students. This study compared the results of a VIVA examination of two physiotherapy cohorts in preparation for future clinical placements; the experimental group who had access to two video based clinical cases and the previous cohort, who did not. The viva was an end of module assessment and prior to the VIVA for the experimental group, videos were developed to demonstrate a 'good' and a 'bad' demonstration of the VIVA. Cases were developed by both academic and clinical staff in an area of cardio-respiratory and neurology and these were demonstrated by a new graduate. For each scenario, the graduate was video captured performing a less competent demonstration and then, after some coaching, repeated the demonstration to a much higher standard. This was made available to students prior to the VIVA and a questionnaire was used to capture the student opinions. A follow up focus group of six students was then used to gain a better understanding of the questionnaire findings. Results showed a 93% satisfaction with the video and that 98% think this should be used for future cohorts. Thematic analysis from the focus group report two themes of 'supportive' and 'critical' and five subthemes, which include an increased understanding and decreased anxiety about the VIVA.

There were significant improvements in overall score from 78% (n=50) for the non-video cohort, to 81% (n=62) for the video cohort, however the reduced cohort size of 50 or the previous cohort is not discussed as a possible explanation for the results. This may be an interesting finding if the decision to use video was due to an increased cohort size and its use helped support a larger number of students to better effect. On closer examination of the survey opinions, the lowest scoring questions were about the prior use of video and the ease of finding the video resources to support the VIVA. Responses of 56% and 73%

satisfaction illustrate that students would like to see more extensive use of video, and these should be easy to find on university systems.

Jones, Dean and Hui-Chan (2010) also explored the use of video on assessed grades in cardi-orespiratory physiotherapy knowledge but found contrasting objective results. This study was performed in universities in two countries (Canada and Hong Kong) and featured two experimental groups plus a control group. Year 2 students were recruited from Hong Kong and tear 3 students from the Canadian university and were randomly allocated to one of the three groups. Video-linked tutorials and web-based tutorials (experimental group 1) were compared with web-based tutorials only (experimental group 2) and lecture-based tutorials (control group). Groups therefore contained participants from both universities and could work collaboratively online to develop their understanding of the subject area. Knowledge was measured using a short answer quiz around the topics of oxygen transport and manual hyperinflation. No differences were seen in the mean scores for the topics across the three groups apart from the web-based Hong Kong group who recorded lower scores in oxygen transport. Qualitative feedback was also complied and collected using four priori themes. Whilst it is not clear if the content was accessed using mobile or fixed technology, it does comment that participants preferred smaller working groups and had to concentrate much harder in online sessions than lecture-based sessions. They also report that they trusted in-formation more when it came from academic staff rather than from themselves.

Whilst this may help develop motor skills, it perhaps also provides a focus once more, for research into instructor generated rather than student generated resources. Much of the research around both technology enhanced learning and learning mediated through mobile devices has a focus upon the opinions of instructor-based resources. This applies both within physiotherapy research and external to the profession. The influence of multimedia-based resources has been clearly established and is valued by students within physiotherapy, however the ubiquitous nature of smartphones and tablet-based technology pose a question around the influence that these forms of personal technology may play in skill acquisition but also in a wider student learning context.

Maloney et al. (2013) demonstrated in a randomised trial that greater clinical competency was achieved when a combination of traditional teaching was combined with student produced videos in a cervical spine scenario. The study recruited 60 undergraduate physiotherapy students who were randomised to either a traditional practical tutoring group (50%) or an experimental group. Both were taught the same complex clinical skill, but the experimental group had a self-video task that encouraged reflection on performance. Results of an assessed OSCE demonstrated significantly higher scores (p=0.048) in the self-video reflection group. It is unclear if the videos were produced using mobile devices but does hint at the potential that this type of student generated content has for development of personalised clinical skills and as a reflective tool. The study did not explore the results further with a follow-up qualitative study to understand if this approach was valued by participants or had encouraged a more expansive adoption of the self-reflective approach through use of video. This would provide a better understanding of whether technology acceptance in this case was short-term and driven by academic assessment as has been seen in many studies using TAM models, or if it did provide a platform for meaningful change.

Blackstock et al. (2013) also used video as part of two simulation RCTs within a cardiorespiratory context in a population of entry-level undergraduate physiotherapy students. Patients from clinical practice were videoed and a script was developed for trained actors to follow and participate in the trial. Participants (n=90 in each group) were exposed to either a simulated learning environment (SLE) or a 4-week clinical immersion period. The SLE was delivered either as 1 week in SLE and 3 weeks in clinical settings (RCT1) or 50% in SLE and 50% in clinical setting for the first 2 weeks of a 4-week clinical immersion period (RCT2). This was a non-inferiority trial and results showed no significant differences between the groups in student competency, concluding that a SLE may act as an alternative for clinical time in a SLE using different percentage models split between clinical practice and SLEs. Although the video used was not student generated, the results create a discussion platform for the use of video as an alternative to clinical practice. The issue of learner autonomy was not the aim of this study however, but it once more illustrates the influence that video has upon clinical skill development and preparation for clinical practice within physiotherapy.

Coulson and Frawley (2017) considered student generated content when they asked, 'what are students' perceptions and attitudes to digital student-generated assignments in learning physiotherapy within a higher education context'? They explored the effect of mobile mediated learning upon student achievement in a single physiotherapy cohort but used an assignment completion task rather than an OSCE or MCQ based approach. They explored how student-generated multimedia supports learning in an undergraduate physiotherapy course using a short vodcast (4.5 minutes in length) to explain a multisystem physiotherapy related problem to the 'lay' population. Details of the exact criteria were sparse, but they reported that this was a group assessment which incorporated an individual reflective element as part of the criteria. They concluded that student generated vodcasts allow development of a student's clinical technical ability and skills demonstration. This study does raise an important 'gap' that exists around student generated content as a vehicle for learning and how this may compare to instructor-based resources. It highlights an important consideration that students are assumed to have these skills and are not commonly assessed in this area. It also states the emergent shift towards the use of video and multimedia for higher education learning but deliberates the limited use and evaluation of student generated content. This study reports that participants used an average of 2.9 devices for the creation of their educational vodcasts, including laptops, tablets, and smartphones.

The use of mobile devices for learning via self-generated content of this nature therefore appears to be an under-researched area. It is clear that mobile mediated learning is a valued tool for accessing recommended resource content, but the freedom to explore autonomous and self-created content appears less well established. Franz and Rowe (2013) argue that careful integration of technology to compliment more traditional teaching methods will enhance physiotherapy education through facilitation of discussion and interaction to bring about higher cognitive functioning. This is a valid argument that is underpinned with the social constructivist learning theory but is applied to clinical practice and addresses technology in general rather than specifically addressing mobile-mediated learning. Thus, an emergent argument exists to explore opinions and ultimately, the influence of this as a specific technology upon physiotherapy student learning. Additionally, a better understanding of the usage around self-selected content and self-generated mobile mediated content may clarify if student learning is more powerful when blended, directed, or self-selected.

Summary

The literature review has presented an overview of traditional learning theories together with their strengths and limitations. The emergence of the internet has seen a more digitalised form of learning than in previous years and a move towards a more informal, networked and technology enabled platform (Kezim and Ozam, 2010). This has coincided with the emergence of connectivism as a proposed learning theory for learning in a digital age (Siemens, 2004). Connectivism has been criticised for a lack of credible research in peer-reviewed publications (Kop and Hill, 2008, Kerr, 2006) and its initial popularity has declined in recent years. Described as “social learning that is networked” (Duke, et al. 2013 p.6), it has been described as a pedagogy rather than a true learning theory. Connectivism does however, partially explain how learners engage with autonomous informal networks and engage with learning in local, national and international contexts and how the role of the educator has seen a shift away from a traditional educator to a facilitatory guide. From this perspective, it offers a theory of how learners are now, via social networks, able to access, filter and apply self-selected information from a wider perspective rather than the more limited personalised context of individual experiences and meaning.

The use and acceptance of mobile technology has been explored but is still in its early stages. Research into social media usage has been conducted around technology acceptance using adapted TAM and UTAUT technology models, however these lack the personalisation and choice that modern learners now demand. Specific mlearning acceptance models in primary education have been developed by a few authors (Uzunboylu and Ozdamli, (2011), Uzunboylu and Tugun, (2016)), however these are not specific to physiotherapy and have been performed with educators rather than with a student population. A useful addition to these areas considering the current popularity of mobile technology would be to investigate its use and influence within a specific physiotherapy student population to establish if a predominant learning theory emerges and if study strategies are indeed moving away from traditional pedagogies. Studies specific to physiotherapy student populations have explored the use of resources provided by academic staff, but limitations in the follow up to these have not established to what degree the self-generation and self-selection of study resources influence key areas of practical skill and academic development. This will be important to establish for both educators and students as it is important for educators to understand this and respond to change. Understanding how autonomous choices in learning opportunities mediated through mobile devices are viewed and valued by learners is an area within the profession. It has been explored using a guided academic approach that could encourage learner autonomy, but it remains unclear if this is driven by academic assessment, if it already exists, or if it encourages learners to adopt this approach. This will be an important aspect for educators to understand if they are to successfully facilitate graduates to achieve their potential in the current digital age.

Chapter 3. Overview of Methodology.

This chapter will state the research questions of the thesis and outline the research paradigm for the study with an accompanying rationale for the methodology and methods used in both phases of this mixed methods study. Aims for each phase of the study are stated collectively on p72, and where appropriate aims of the pilot study/cluster/factor analysis and specific hypotheses for the quantitative study are stated separately, later in this chapter. The rationale for a pragmatic approach is discussed, together with an overview of the alternative research paradigms to this and how these approaches integrate with a mixed methods approach. The choice of a sequential explanatory mixed methods design is discussed, together with a description of how the survey questionnaire informed the selection of a purposive semi-structured interview sample.

Research Questions:

Thesis Research Question.

How does a pre-registration student physiotherapy population use mobile mediated learning as a vehicle for learning in a specific professional context?

Quantitative Phase Research Question

How do opinions of mobile mediated learning use vary and, therefore, drive learning behaviours in a pre-registration student physiotherapy population?

Qualitative Phase Research Question

What influence do mobile technologies have on the learning of pre-registration physiotherapy students in specific contexts of physiotherapy education?

This thesis attempts to answer these questions, integrate the findings and discuss the influence that these technologies contribute to pre-registration physiotherapy student learning to better understand how, as an educator, I may offer future pre-registration students' and fellow educators' practical advice with regards to their use.

Research Paradigm.

Usually described as a system of ideas or theoretical principles that determine how an issue is considered, research paradigms have been subject to much debate. Often accepted on faith with no way of ultimately establishing their truth, they are described by Guba and Lincoln, (1998) as a set of basic beliefs. Much of this debate arises from traditionally bi-polar opposite ends of a paradigmatic spectrum, where at one end, the positivist/post-positivist, naturalistic (quantitative) paradigm sits, and at the opposite end, the constructivist (qualitative) paradigm (Plowright, 2011). What distinguishes these paradigms is how researchers make conclusions and claims about this knowledge and indeed, what constitutes knowledge. The ontological position is concerned with the nature, constitution and structure of reality of the world and what there is to know about it. Hayward, Cardinal and Jones, (2004) posit that ontology is also concerned with the theory of what exists and the theory of being. The epistemological position is concerned with how we know or can find out about the social world and what are the limits of this knowledge (Ritchie, et al. 2013). This may include a bottom-up inductive logic approach where knowledge is built or constructed through observation, or a theory testing, hypothesis driven deductive approach where acceptance or rejection of these hypotheses strengthen or weaken these theories.

Constructivism is more typically associated with these bottom-up inductive approaches that are aligned with a qualitative paradigm where individual perspectives are analysed and shaped into broad patterns and understandings (Creswell and Plano-Clark, 2011). The positivist/post-positivist paradigm informed by realism, idealism and critical realism assumes that one reality exists and that this is discoverable within the laws of probability and is hence more associated with the deductive top-down hypothesis driven approaches to research. A caveat to the post-positivist approach is that in contrast to positivists who view the researcher and the research subjects as separate entities, post-positivists acknowledge the influences of theory, background, knowledge and beliefs upon the researcher and therefore the potential biases that may exist. For this reason, post-positivists consider both qualitative and quantitative approaches and methods to be valid (Robson and McCartan, 2016).

Mixed Methods Paradigm

The emergence and development of the mixed-methods paradigm has in part stemmed from a division and divide across these paradigms over the late twentieth and early twenty-first centuries. Teddlie and Tashakoori, (2009) attribute a marginal acknowledgement to Aristotle as a 'proto-mixed methodologist' (p.47) because of his belief that scientific thought and knowledge relies on both inductive and deductive methods. Aristotle described the process of induction where observation of as many examples of a phenomena as possible, followed by analysis to discover the general underlying principles would explain that phenomenon. Indeed, the Ancient Greek civilisations, philosophers created knowledge and theory through deduction and measurement until around 500AD (Teddlie and Tashakoori, 2009).

The rise of Christianity in the Middle Ages from 500AD until around the end of the 15th century saw a move from inductive knowledge generation to a scripture and writings-based model. The Renaissance period that followed from 1500-1700 saw a paradigmatic shift during which innovations in science and philosophy were conceived. Many including Francis Bacon argued that scientific methods involving data and experience combined with experimentation and observation should herald the knowledge generation. Bacon introduced a system of empiricism and introduced the concept of personal beliefs clouding the empirical process; hence, they should be avoided (Teddlie and Tashakoori, 2009). Others including Galileo viewed experimental research data and mathematics as important facets in the scientific method. This period marked a deviation in thinking from Aristotle's passive thinking philosophies to one of active experimentation, which became the hallmark of the scientific method.

The Enlightenment period at the end of the 18th Century is perhaps a further example of a deviation in thinking as the idea of human reason as a universal characteristic was emphasized. The light turning upon the enquiring mind led to an increase and growth in social research which in turn, led to a split between the positivist quantitative approach and the constructivist qualitative approach as opposing views emerged. New disciplines such as psychology, sociology and education emerged as a result of this increase in social enquiry and led to further divisions between paradigms, but also led to innovation within qualitative methodologies (Bielsa, 2016). Amongst these were the development of Grounded Theory (Glaser, Strauss and Strutzel 1968) and data verification procedures such as those developed by Denzin, (2017). Denzin describes the process of triangulation and how this could be a useful method to reduce bias inherent in any research study and to cross-validate research findings. This method of triangulation was divided and defined into four distinct types. These were, firstly, data triangulation where a study may utilise different data sources; secondly, investigator triangulation involving additional researchers in a single study, thirdly, theory triangulation, where interpretation involves multiple perspectives within a single data set, and lastly, methodological triangulation, involving multiple methods within a study.

Rationale for Mixed Methods Paradigm and Methodology

The use of multiple methods within a single study led to the emergence of mixed methods research, firstly in the educational domains within American research, before gaining increasing popularity in Europe. The work of Charles Pierce and William James in the late 19th, early 20th centuries and John Dewey (Morgan, 2014; Plowright, 2011; Omerod, 2006) in the mid-19th century is frequently cited as the starting point for 'Pragmatism' as a research paradigm that embraces both qualitative and quantitative paradigms. Arguably, as described by Omerod, (2006), American pragmatism developed out of European philosophy and fed back into it.

The core principles of pragmatism are that actions are guided by a set of beliefs and should be judged against outcomes rather than principles (Morgan, 2014). Although this is of importance, it is also important not to consider these belief-based actions in isolation, and indeed that there is consideration of social actions directed towards other people. Goldkhul, (2001) presents a view of this with the socio-instrumental pragmatist framework "which can be seen as an eclectic framework inspired by social action theories" (Goldkhul, 2002 p.2). A socio-instrumental pragmatic framework proposes that humans possess an inner world of knowledge about themselves and the external world. This knowledge is part shared via speech and written communication and part individual e.g., thoughts, feelings, plans intentions etc. From this inner world, comes a set of human actions that may be overt in the shape of interventions including spoken/written communication and which ultimately conclude with a particular result or outcome with the external world. Interpretive covert actions about how subjects interpret reality also exist in this inner world in addition to reflective ways of using language.

This pragmatic approach to research addresses both ontological and epistemological positions, as a core idea of ontology is that phenomena exist and have locations somewhere. The question regarding influences of mobile technology on learning behaviour is a proposed phenomenon of interest in this study, but does it exist, what kind of phenomenon is this, and where does this exist? Using a mixed methods approach to study this phenomenon embraces the complementary methods of deductive-inductive methods to construct meaning from data in a more meaningful way than a single method alone. The additional use of data and method triangulation will give context and understanding to the study population and improve the validity of the results (Denzin, 2017). Perhaps Ivankova, Cresswell and Stick, (2006 p.3) contextualise this well when they state,

"The rationale for mixing both kinds of data within one study is grounded in the fact that neither quantitative nor qualitative methods are sufficient, by themselves, to capture the trends and details of a situation."

Research Approach.

The research approach is framed around a mixed methods methodology in which a core qualitative methodology follows on from an initial quantitative methodology. As described earlier, this methodology is known as the sequential explanatory methodology (Cresswell and Plano-Clark, 2011). Morgan, (2014) describes the motivations for follow up qualitative phases as extensions to quantitative studies in three ways. Firstly, they can act as an exploration of quantitative studies, where an explanation of how and why a particular set of results occurred. Secondly, investigation is concerned with the interpretation of specific patterns in the data and thirdly, illustration is concerned with describing the basis for the results. The methodological approach for the qualitative phase of this study will be to seek explanations for how and why the results from the survey questionnaire occurred. The use of in-depth interviews to follow on from the survey questionnaire is to develop explanations that are not presented within the results of the survey questionnaire (Morgan, 2014) and to discover more about the interview sources themselves. A desirable strategy of follow-up interviews is to use cases from the original survey. This type of mixed methods approach was possible using a quant → QUAL design as the same sampling strategy was possible due to all cases from the initial survey questionnaire being available. The qualitative phase of this research is the principal data collection method, following on from the preliminary quantitative phase as described by Morgan, (2014).

Mixed Methods Methodology.

The study will consist of 3 distinct phases, which include, the initial quantitative survey questionnaire, followed by the qualitative phase, and finally a convergence phase where the results of the two studies will be used to formulate the study findings. The study diagram (figure 3.1) gives the details of each phase.

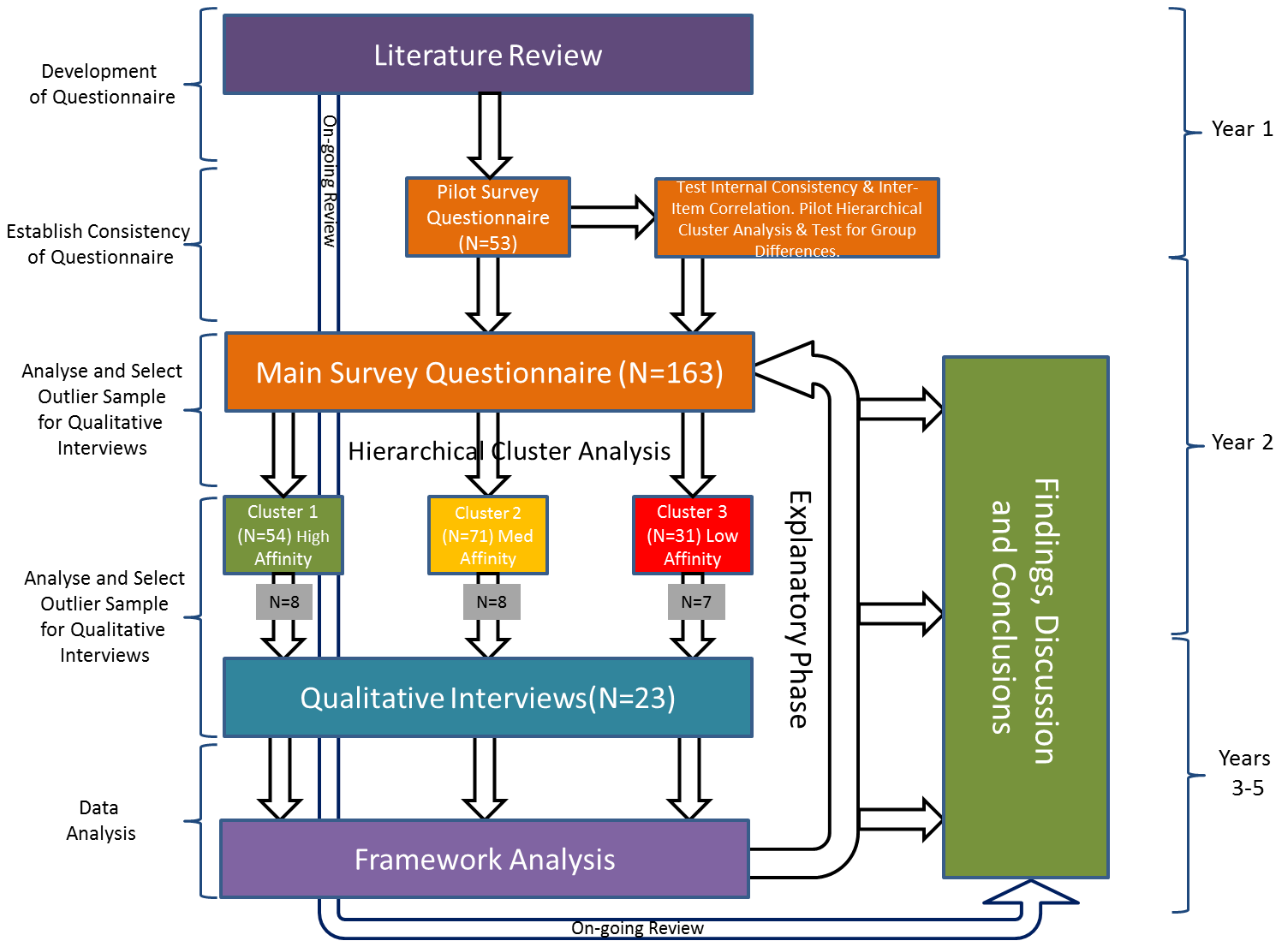


Figure 3.1 Study Diagram Showing Development and Progression of Study.

To assist the reader, each phase of the study will be shown diagrammatically to represent how each phase developed and built on the previous phase. Phase 1 is shown in the following pages and represents the starting point of the study. The literature review was ongoing and continuous throughout the entire study but is not named as a specific phase.

Methodology.

Phase One Pilot Questionnaire Design.

The survey used in this research was a simple descriptive survey with a single group of participants (Pre-registration Physiotherapy students). The advantages of such a design are that they give useful background information about a sample and can be administered widely in a single setting. They are also reliable and are easily completed. However, participants often do not like survey questionnaires, and they can provide only superficial information (Edwards and Talbot, 2014). By the nature of their design, survey questionnaires also produce descriptive data; hence the analysis is constrained to largely descriptive results that lack explanation. The survey was developed and tested through use of a pilot study prior to beginning the main study. The steps in this design are shown figure 3.2 below.

Phase One Quantitative Survey Pilot Questionnaire

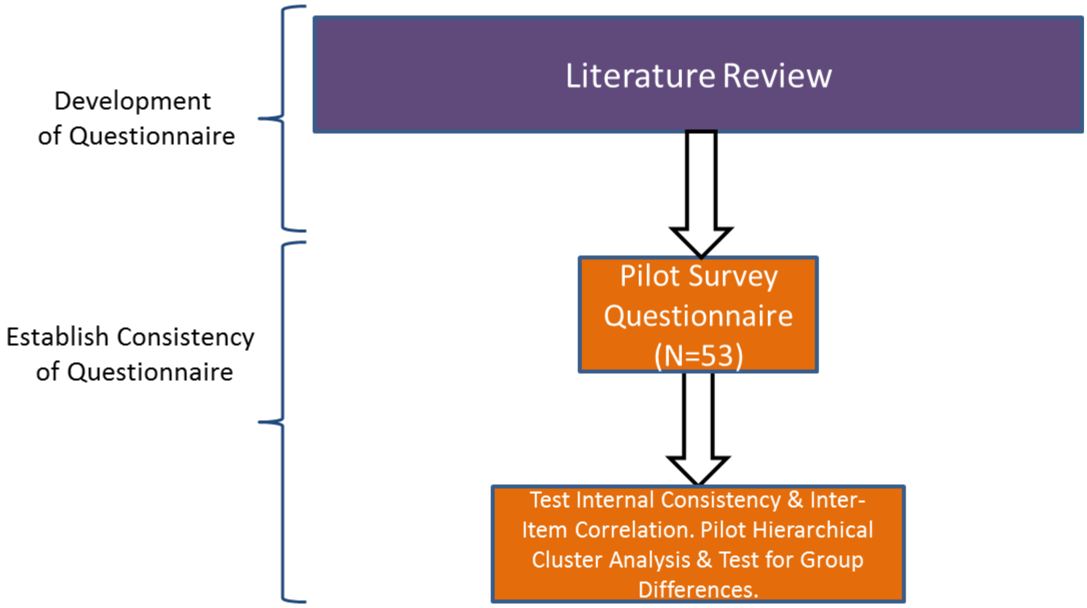


Figure 3.2. Study Diagram Showing Phase 1a of Study. Quantitative Pilot Survey Questionnaire

Rationale for Design

Surveys or questionnaires are a commonly used method to collect data from research respondents. Bowling and Ebrahim, (2005) comment that they are useful for collecting information about specific groups of people or specific topics. This can be true where limited sources of data occur, or existing data sources may be insufficient in their level of detail.

Surveys exist in many formats, often being described as simple, descriptive, cross-sectional, continuous and longitudinal. Simple and cross-sectional surveys are conducted only once with either a single group of participants (simple) or with more than one group (cross-sectional). Continuous surveys are repeated over time with different samples, whereas longitudinal surveys follow is repeated but follow a sample of people (Bowling and Ebrahim, 2005).

Pilot Survey Questionnaire Development

A 31-point pilot survey questionnaire was developed between February and December 2015 with the aim of providing responses to factual questions e.g., demographic data, and to collect student opinions around their own use of mobile devices for education, to explore if opinions were wide and varied. Finally, the questionnaire was tested to explore if a smaller suitable purposive sample for follow up qualitative interviews could be identified. The main survey questionnaire aimed to explore the patterns of mobile device usage within a population of Physiotherapy students, hence the pilot study was tested using an associated (undergraduate nursing students) population. This group was not included in the main study data. This included exploration of the primary use (e.g., organisational, leisure, lifestyle, communicational, educational) for the mobile device and how mobile devices were used for learning purposes as part of their university studies.

Although it is well documented by authors such as Polgar, (1995) and Greenfield, (2002) that convenience sampling is inherently biased and difficult to assess in terms of measurement of this bias, the study focussed on this group of students to investigate their mobile learning habits/trends. Biggam, (2011) suggests more detailed and representative research is produced in explanatory research when convenience sampling is used.

The pilot survey questionnaire was initially developed by the Principal Investigator and was distributed to a small group of three reviewers unconnected to the research subject area. The questionnaire was grounded in the research around the learning theories of constructivism, connectivism and the acceptance of technology models outlined in the literature review. Routing questions were not a feature of the questionnaire and questions followed a numerical order. The questionnaire consisted of factual, open, closed and opinion based questions. The use of the three TAM models (Davis, 1989, Venkatesh, 2000, Venkatesh and Bala, 2008), plus the UTAUT (Venkatesh, et al. 2003) were considered, however these models apply to technology that is not selected by the user and applies to technology acceptance that is introduced at organisational level. The development of a more 'customised' model was therefore preferred; however, these models were used as a useful framework around which to develop questions with a focus on self-selected technologies. Figure 3.3 demonstrates how the TAM1 model was adapted for the survey questionnaire and how the questions relate to the model.

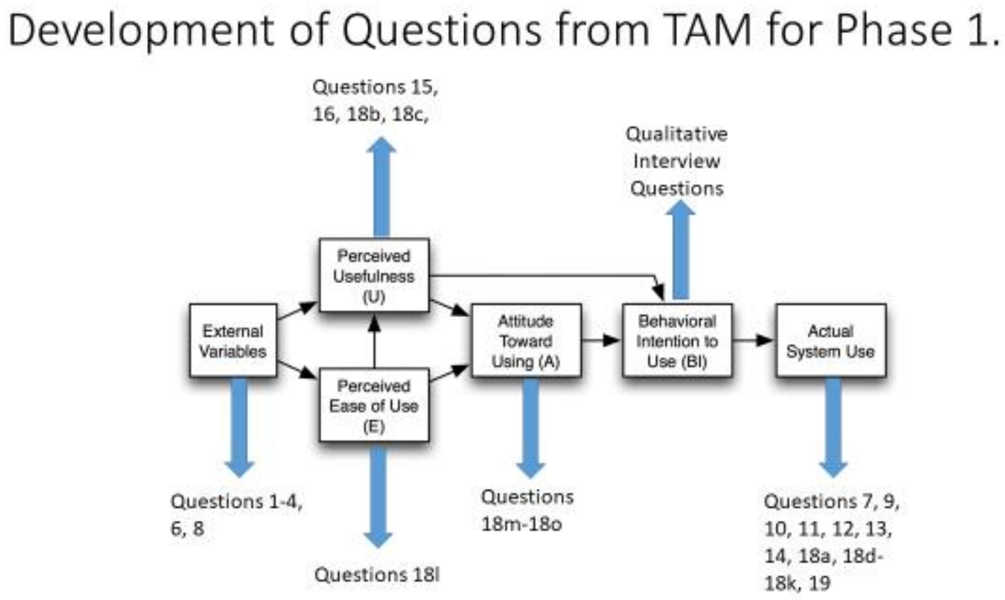


Figure 3.3. Development of Survey Questionnaire from TAM.

The use of three reviewers was to establish a degree of face validity and assess the general understanding of the survey questionnaire. Whilst face validity is a relatively subjective and "casual" form of reliability, it may be used to establish a degree of understanding and interpretation (Litwin, 1995). As face validity lacks a degree of scientific measure, content validity was also explored. The survey questionnaire was distributed to a selection of eight reviewers, all of whom are employed within Higher Education, work within an Educational Health Care discipline and have been involved in research teaching. Comments were received from six of the reviewers with suggested revisions regarding structure and content. The survey questionnaire was amended to reflect these comments.

Rationale for use of Attitude Scales within Survey Research

Within survey research, data can be generated that explores the behavior of respondents. This can allow a more in-depth analysis of the data and is often produced with the use of attitude scales. These differ from survey questionnaire responses as they involve the use of statements to which participants are asked to show the extent to which they agree or disagree. This differs from typical survey questionnaire responses that describe what do or have done (Edwards and Talbot, 2014). As the survey questionnaire intended to explore patterns of use with mobile devices, it was important to discover the prevailing attitudes and behaviors behind these uses, hence attitude scales were used within the survey to explore at a slightly deeper level, the 'drivers' for these behaviors''. Commonly used methods for attitude scales are Thurstone and Likert scales. The Thurstone scale is an attitudinal scale in which participants are expected to endorse statements that exhibits their position on an attitude continuum. They have high reliability but are time intensive to complete, with some authors commenting that they can take twice as long to compile as rating scales with no improvement in reliability (Beri, 2008).

Likert scales are like Thurstone scales but as participants make agreements and disagreements towards a favorable or non-favorable response, they are easier to show cumulative favorable responses to a behavior or attitude. This 'endorsement' versus 'favorable' deliberation perhaps gives the Likert scale an advantage over Thurstone scales given the relative infancy of mobile learning where endorsements may not yet exist. However, it should be stated that cumulative favorable responses of the Likert scale do not constitute an 'attitude score' for the whole scale and there is a compromise between simplistic construction and analytic sophistication. The Likert scale has other advantages over the Thurstone scale in addition to these as Beri, (2008) cites that they have higher reliability co-efficients, whilst also being less laborious and less time-consuming.

Lu and Viehland, (2008) report that user attitude towards mobile learning is a key behavioral factor influencing adoption of this type of learning. They report this, in addition to other factors such as the perceived usefulness of mobile learning, perceived ease of use, self-efficacy, subjective norm and financial resources. These attitudes therefore seem appropriate to investigate using attitude scales.

Method.

Data Collection and Pilot Sample and Questionnaire Consistency and Revisions.

Survey questionnaire consistency was assessed using a small pilot sample of participants who were similar to the main study sample (N=53) as recommended by Fink, (1995). This data was collected using three individual class cohorts of non-physiotherapy pre-registration health science students based at Northumbria University. Classes were approached prior to the commencement of teaching sessions (with consent of relevant lecturers). Prior to the distribution of the questionnaire an oral presentation was given by the PI that outlined what the research involved and why the class had been invited to participate. Information sheets and consent forms were distributed to potential participants and that the PI would return 1 week later to distribute questionnaires to those willing to participate. The group sizes varied from 20-25 which was important as this replicated the class size for Physiotherapy students and allowed interaction with those participantswho had difficulty with some questions. It also allowed the PI to assess the level of distraction and discussion when completing the survey questionnaire in a classroom situation and if more space was required between respondents. The PI returned 1 week later and distributed additional consent forms where required and questionnaires to all willing participants. These were distributed in paper/hard copy format and were placed face down on individual desks. Additional members of the class who were not present for the original class presentations were not included in the pilot study participants. Participants were reminded of the study aim and instructed to answer with their own opinions and that there was not a right or wrong answer, but their responses would help inform future work in this area.

It appeared from observations that answers were not discussed on a wide scale and that the individualised desks were appropriately spaced (approx 1 foot distance), thus perceived biases and contamination of the data were minimised. The participants were instructed to complete the questionnaire in permanent ink and turn their completed questionnaires over to the face down position when complete. The PI collected the questionnaires when the final participant had completed this together with the consent form.

The issue of timing was also considered with respect to data collection. The pilot study participants were sampled using convenience sampling and were selected according to their year of study in order to achieve a balance of participantsstudying at levels four, five and six (one from each level was selected). It was important, particularly for participants studying at level four, to allow a sufficient adaptation period after beginning University. Many respondent may not have been encouraged to use mobile devices for learning purposes in previous educational establishments, hence data collection at the beginning of the academic year may not have provided valid data. Data collection therefore commenced in January, after the initial September 'term' had passed.

The sample population for the pilot survey questionnaire included healthcare based students who were not student physiotherapists but were from related professions. The data from these participants was not included in the main study.

Internal Consistency

Cronbach's Alpha is a measure of homogeneity and the extent to which items relate to a particular dimension in a scale (Bowling and Ebrahim, 2005). This was used to test the internal consistency of the pilot survey questionnaire.

Pilot Survey Questionnaire Reliability

As part of the 31-point pilot, participants were asked to rank a sub-series of 11 attitude (Likert) scale questions designed specifically to explore how participants favoured using their mobile devices. These were concerned with using the device as a storage unit, an information access tool to enhance knowledge and understanding, an analysis and application tool, a creative resource tool, an appraisal tool, or a supplementary learning tool. Questions were phrased as statements and the participants were asked to rate these on a five-point Likert scale ranging from 'strongly agree (ranked 1) to strongly disagree (ranked 5). The use of a five-point scale has been debated, particularly around the over-use of the third (middle) point (Garland 1991, Armstrong, 1987); however, many authors feel that a genuine neutral response should not be denied to respondents. Questions were assessed for internal consistency using Cronbach's Alpha statistic. A reliability co-efficient of r=0.70 was set as the acceptable co-efficient value for this phase of questions.

Revisions to Survey Questionnaire

Cronbach Alpha scores returned from the pilot survey questionnaire, that were below 0.70 were then subject to revisions (four questions) rather removing these from the main study. The revisions were made as the same question was interpreted differently by different respondents. It was concluded that the inclusion of examples may add more clarity to the question and provide a more consistent interpretation for respondents. Revisions were made to the four questions that had been removed after analysis with Cronbach's Alpha statistic and an additional four questions were included that explored the competency of use and training needs with mobile devices. The revisions to the four questions that were removed involved rewording of the statements e.g.

> Mobile learning helps me to link to other types of information e.g., through web-sites, YouTube etc. that aid my understanding of a course concept

Was reworded to

> Mobile learning helps me to make links to types of information and helps connect these together e.g., a resource (e.g., website, YouTube video, Twitter feed, Facebook link) may have a link or links to other learning resources, e.g., YouTube etc. that aid my understanding of a course concept.

Other questions were clarified with the use of an example e.g.

> 'I use my device(s) to assess my performance and skills'

Was revised to

> 'I use my device(s) to assess my performance and skills e.g., by video capturing and analysing my performance of skills.'

The rationale for the introduction of new questions was based upon comments made by Lu and Viehland, (2008), who describe the 'ease of use' of mobile technologies as being an important factor in attitudes and behaviours. Hence the questions below were included to explore the respondents' confidence and general competence in using mobile technologies. Are participants engaging in learning via mobile devices simply because they do or do not feel equipped with the skills to do so?

> 'I feel confident that I am equipped to use mobile devices to effectively facilitate my learning'

and

> 'I would like to see sessions that encourage the use of mobile learning within taught sessions in University'.

After inclusion of the four revised questions and four 'new' questions, the survey questionnaire was retested for internal consistency and a revised Cronbach's Alpha was calculated based on these fifteen items. The results of the revised Cronbach alpha calculations are presented in Chapter 4.

Survey Questionnaire Main Study.

Quantitative Phase Research Question

How do opinions of mobile mediated learning use vary and, therefore, drive learning behaviours in a pre-registration student physiotherapy population?

Sample Size.

The aim of recruitment for the main study was to recruit a representative sample of pre-registration physiotherapy students (both BSc and MSc). It was important to capture views from both programmes to represent opinions and consider aspects such as study level in addition to age, gender etc. The total of (at that time) 220 current Northumbria Students represented the available population from which participants were drawn. Using the online Survey System power calculator, a sample size calculation returned an ideal sample size of 140 based on 95% confidence intervals from this population size of 220. A margin of error of 5% as recommended by Burmeister and Aitken, (2012) was factored in as was a 15% drop out rate, hence an overall sample of 161 was targeted.

Sample Recruitment for Main Study.

The main study data was collected in keeping with the pilot study using the individual year cohorts of physiotherapy pre-registration students based at Northumbria University.

Classes were approached prior to the commencement of teaching sessions (with prior consent of relevant lecturers). Classes were approached during periods where the PI was not closely involved in the teaching or marking to lessen the risk of formal coercion, and an oral presentation was given as per the pilot study. A mobile device was defined to the participants as a device where it is possible to use with two hands whilst standing up or on the move and included smartphones, iPods, tablets, and mini tablets, but not laptops. It was also explained that learning enabled by the mobility of the learner and the portability of handheld devices should also be considered when answering questions posed e.g. during travel, waiting time etc. and that these would constitute learning if engaging with physiotherapy and professional contexts etc.

Data was collected during occasions where desk spacing was possible and a distance of approximately 1 foot was again introduced for questionnaire completion. Consent forms and information sheets had been distributed 1 week prior to questionnaire completion to allow potential participants the opportunity to ask questions prior to questionnaire distribution. In line with pilot study procedure, questionnaires were distributed face-down and were collected once the final participant had completed the questionnaire. Completed responses and consent forms were then collected and placed in an envelope for later data input.

Data Analysis

Pilot study response data was entered into SPSS version 22.0. and this was analysed using both univariate and multivariate statistics. Descriptive statistics (mean, SD, cross-tab and frequencies) for demographic data variables such as age, gender, year of study, and previous academic background.

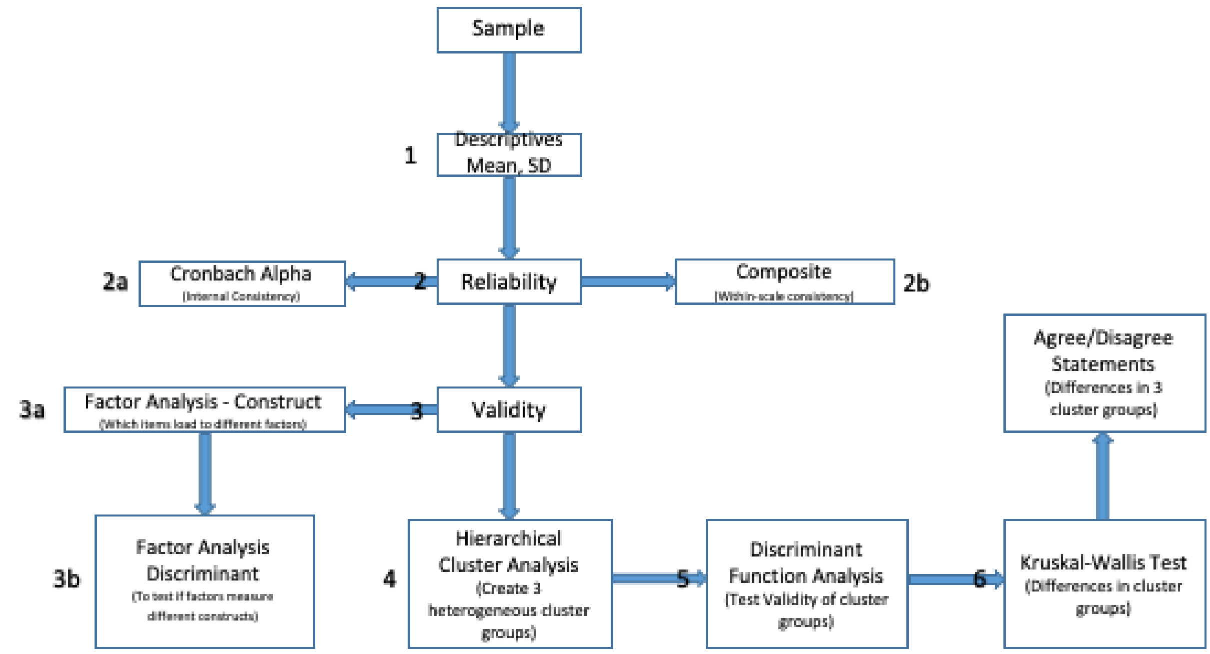
Reliability and Validity

Reliability and interal consistency of the main questionnaire was established using Cronbach alpha statistic to assess that questions posed were interpreted consistently. Construct validity was tested using Factor Analysis to explore if different 'constructs' existed within the questionnaire. The use of discriminant factor analysis was then applied to assess if any 'constructs' were independent of one another.

A hierarchical cluster analysis (HCA) was used with the aim of identifying collective group responses in the data (did different groups exist) and explore the appropriateness of this method in producing a maximum variance sample for qualitative interviews in the main qualitative study based upon these group responses. As the data used for this was ordinal level (derived from Likert scales with three independent data sets), the use of non-Parametric tests was indicated (Field, 2013). This process was piloted and produced data sets that were felt to be appropriate for use with the main study. The clusters from the HCA were then tested for validity (were they different from one another) using a discriminant function analysis.

Once the data had been subjected to these tests of validity and were found to exist as independent groups, the data was finally explored to test if distinctive/different cluster responses existed using Kruskal-Wallis (KW) Tests. Dunn's Post-hoc test with Bonferroni adjustment were used to identify where any significant differences identified in the KW test occurred. These results are presented in Chapter 4.

An overall summary of the steps involved in the data analysis is shown on P93. together with a brief rationale for each stage.



Ethical Considerations

This research centers on the current use of mobile learning tools in health care student populations at both undergraduate and postgraduate levels (pre-registration). The aim of the questionnaire is to explore what current tools are being used, by whom and how. Therefore, groups of students from these fields will be asked to complete the questionnaire to answer this query.

No special requirements were required other than to complete the written questionnaire in the English Language in permanent ink. Participants were given the option of completing this at any time of day and then returned anonymously to the PI in a sealed envelope. Alternatively, participants can complete the questionnaire in the presence of the researcher, and hand completed responses to them directly. The choice was completely optional. No specific exclusion criteria were used, though it was generally understood that owning or having access to a mobile learning device was important to participate fully and complete the questionnaire. Participation simply involved completing a written questionnaire and involved no physical discomfort.

The study and its protocol received full ethical approval from the Northumbria University Ethics Committee (Ethics Reference number hlsmp071014). There were no cash incentives for taking part. During the study itself, if participants decide not to take any further part, then they informed the PI as soon as possible, who facilitated withdrawal and discussed how data will be treated in the future. There were no withdrawals from the study.

Qualitative Methodology.

This section will present how the qualitative phase of the study was integrated with the quantitative survey questionnaire and a rationale for the methodology used. This phase was the second phase of the mixed methodology approach. The section describes the methods used to select the sample and considerations associated with this, given that the quantitative phase identified three separate groups. Therefore, this section presents the method used to ensure an appropriate sample was selected that included a range of participants from each group and across all groups. The survey questionnaire constructs helped identify some of the opinions that contributed to the interview schedule, e.g., around access, creativity and proficiency. This will be further described to include how the actual data collection was conducted and evolved over the time of the study. Finally, an overview of the framework method of data analysis is given and the rationale for its selection

Qualitative Phase Research Question

What influence do mobile technologies have on the learning of pre-registration physiotherapy students in specific contexts of physiotherapy education?

Context of the Study.

Figure 3.4 demonstrates the continuation of this phase from the survey questionnaire and how this partly informed the selection of a maximum variance sample for the qualitative interviews (n=23) using hierarchical cluster analysis described in the previous chapter.

Phase 2 Qualitative Interview Phase

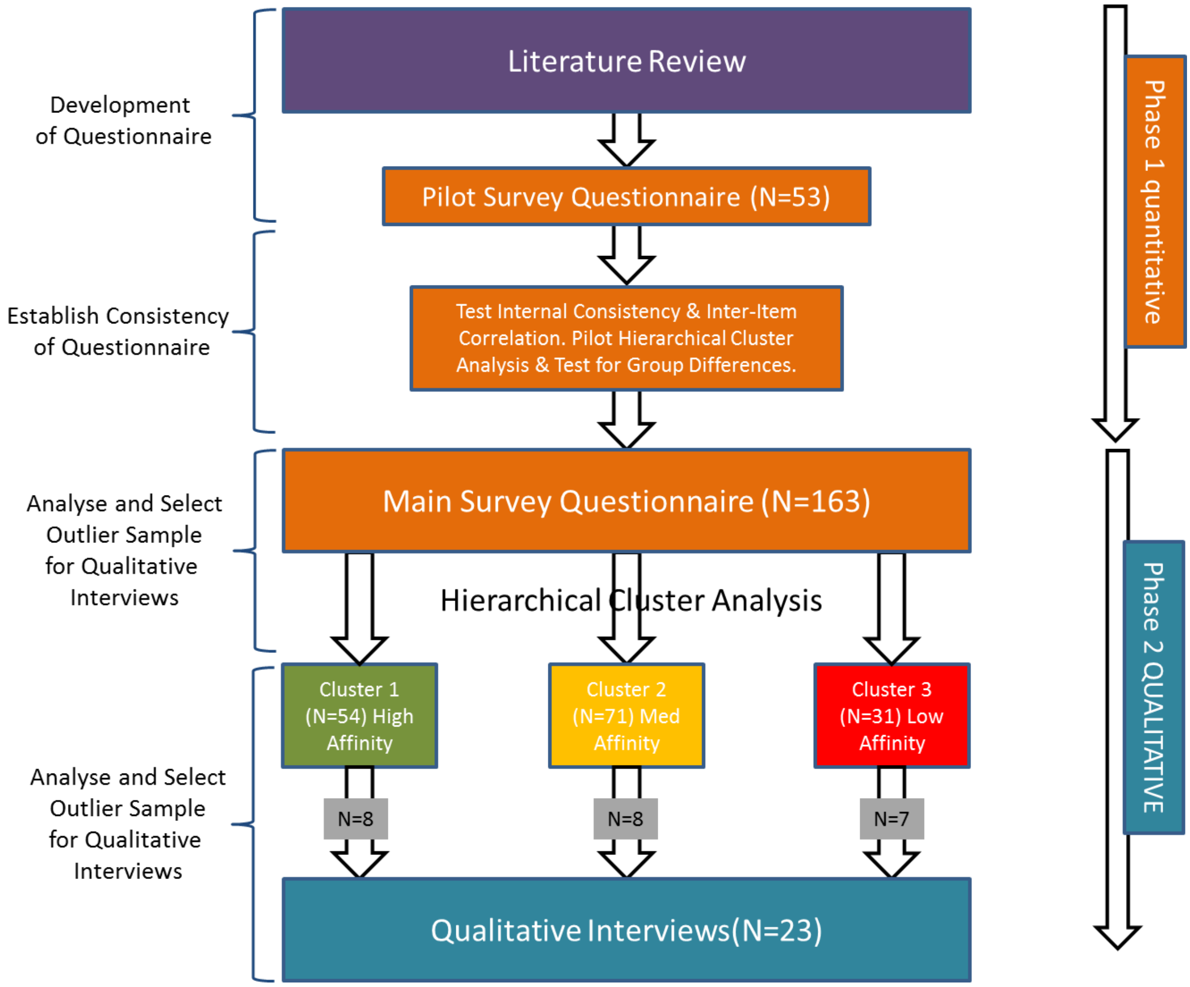


Figure 3.4. Qualitative Interview Phase Development from Initial Quantitative Phase.

Study Cases

Following data analysis of the survey questionnaire (n=163), a purposive approach to sampling was used to generate a maximum variance sample, consisting of 23 cases. The previous sections within this chapter have outlined the methods to show how a selection of potential interviewees were identified from the initial survey questionnaire using a hierarchical cluster analysis. The analysis demonstrated that, based on survey responses, there were differing opinions as to how mobile technologies were used and influenced learning approaches. The aim following this stage, was to select a sample that captured variances across the sample and explored the wide variances that existed both within and across the three identified clusters. These potential cases were then selected and included eight interviewees from clusters one and two, plus seven interviewees from cluster three (23 in total). Data collection occurred between June 2016 and September 2017 where interviewees were selected according to a composite score calculated from their responses to 14 opinion related questions in the survey questionnaire. Each of the 14 questions (Q18a-18o on questionnaire – See Appendix A Part 2) was scored from 1-5 as shown in the table below.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Question	1	2	3	4	5

Figure 3.5. Likert Scoring Scale from Questionnaire.

All participant responses were then totalled to give an overall composite score, giving a possible score from a minimum of 14 (all strongly agree responses) to 70 (all strongly disagree responses). The mlearning usefulness score (scored 0-10) was then subtracted from this composite score to give a possible composite scoring range of 4-70.

Not useful at all										Most useful
0	1	2	3	4	5	6	7	8	9	10

Figure 3.6. mlearning Scoring Scale from Questionnaire.

The low scores in this range, therefore indicated a high affinity for educational mobile learning technology usage, with high scores indicating less affinity.

This had previously been distributed during phase one of the project and had been shown to demonstrate an excellent degree of internal consistency (α=0.842). The potential sample was selected purposively using a maximum variance sampling approach to achieve a range of both high and low scoring composite scores that aimed to recruit a range of prospective interviewees with a balance of opinions. This is described by Teddlie and Yu, (2007) to achieve a high degree of heterogeneity both between clusters and within each individual cluster. The aim was to produce a sample that captured the individuality and diversity of each cluster whilst simultaneously capturing the commonalities of the scores across all three clusters.

Ethical Considerations for Qualitative Phase

Personal Data

The study received ethical approval from Northumbria University in May 2016. This process ensured that the study was performed in accordance with the University ethics and research procedures. Interview participation was based on informed consent, with each interviewee required to sign a consent form prior to the interview. Consent forms and information sheets were distributed via university email 3-4 days prior to the interview. The nature of the research was susceptible to perceptions that consent to participate involved a sense of coercion. The sense that some participants may have felt compelled or coerced to agree due to the power relationships is a potential area of concern. These power relationships thus create challenges and demand that researchers demonstrate 'respect' for people and establish that, in the context of the research, their wishes are considered (Seedhouse, 2009). Participants may have assumed differing stances in this regard, with perhaps a sense that consent was an expectation or that future academic judgement may hinge on the decision to participate or not. This last point is moot, as the judgement could be perceived in both a positive and negative perspective. This was considered and addressed using a combination of approaches, firstly by drawing on positive staff-student relationships that foster social equality between these groups. There are several examples in the programme where such relationships occur, hence the willingness to participate was considered as part of this relationship. Secondly was the approach to gaining consent, which consisted of an informal verbal approach, followed by an individual email via university email address and forwarding of electronic information documents, and finally an arranged date for the interview (individual date). No inducements or penalties were offered, and a 24-hour consideration was given should participants wish to withdraw. For the qualitative phase, interview questions were forwarded at least 24 hours in advance to allow for thinking time. The issue of informal rather than formal coercion could have led to an implicit sense of obligation or fostering of goodwill of the lecturer. Additionally, the avoidance of lecturer displeasure must also be considered, hence there was a benefit to conducting interviews after a time interval between the phases of the study as participants had time to appraise the staff-student relationship and appreciate the nature of the study. Norvoll and Pedersen (2016) suggest that coercion is not straight forward, and informal coercion is underestimated due to in part, the different roles which people identify with e.g., student, health professional, novice researcher, lecturer, coach etc. but can be acceptable if oriented towards collaboration on equal terms, and in some sense, may be beneficial.

The consent form and corresponding interview data file and interview transcript were coded with a random reference number and separated for anonymity purposes. Debrief forms were completed at the end of the formal interview and coded with the same number (See Appendix B). All data was stored on a secure University staff network server that was separate/different to student data servers.

Interviewees were given the option to suspend or terminate the interview where necessary and were informed that they would be provided with a copy of the interview transcript for appraisal, correction (where necessary) and approval.

Rationale for Sample Selection

Robinson, (2014) argues that sampling is central to the practice of qualitative methods but has received a great deal less attention when compared to data collection and analysis. It is deliberated that theoretical and practical concerns centre around four pan-paradigmatic points when selecting a sample. These include a definition of the sample universe (study population, deciding the size of the sample, selecting a sampling strategy and sourcing a sample.

Study Population

Firstly, the sample universe (study population) is identified and includes all cases that may legitimately be sampled. Inclusion criteria for sample selection was that students selected were pre-registration physiotherapy students who had completed an initial questionnaire describing their current study habits with respect to mobile technologies and typical uses. No explicit exclusion criteria were set hence the sample exhibited a degree of homogeneity based on educational status and survey completion. This degree of homogeneity dictates that a degree of contextualised transferability is possible. Robinson, (2014) also raises the issue of heterogeneity of samples where commonalities in a diverse group of cases could be more widely generalisable. The hierarchical cluster analysis demonstrated where this heterogeneity existed and therefore established a rationale for selecting a sample that is educationally homogenous but exhibits heterogeneous (variances) groupings within this. The value of this approach to sampling is it allows the opportunity to establish if behaviours within one particular context apply across different context. In this particular sample, to establish if students assigned to cluster one show similar behaviours and strategies to those in clusters two and three.

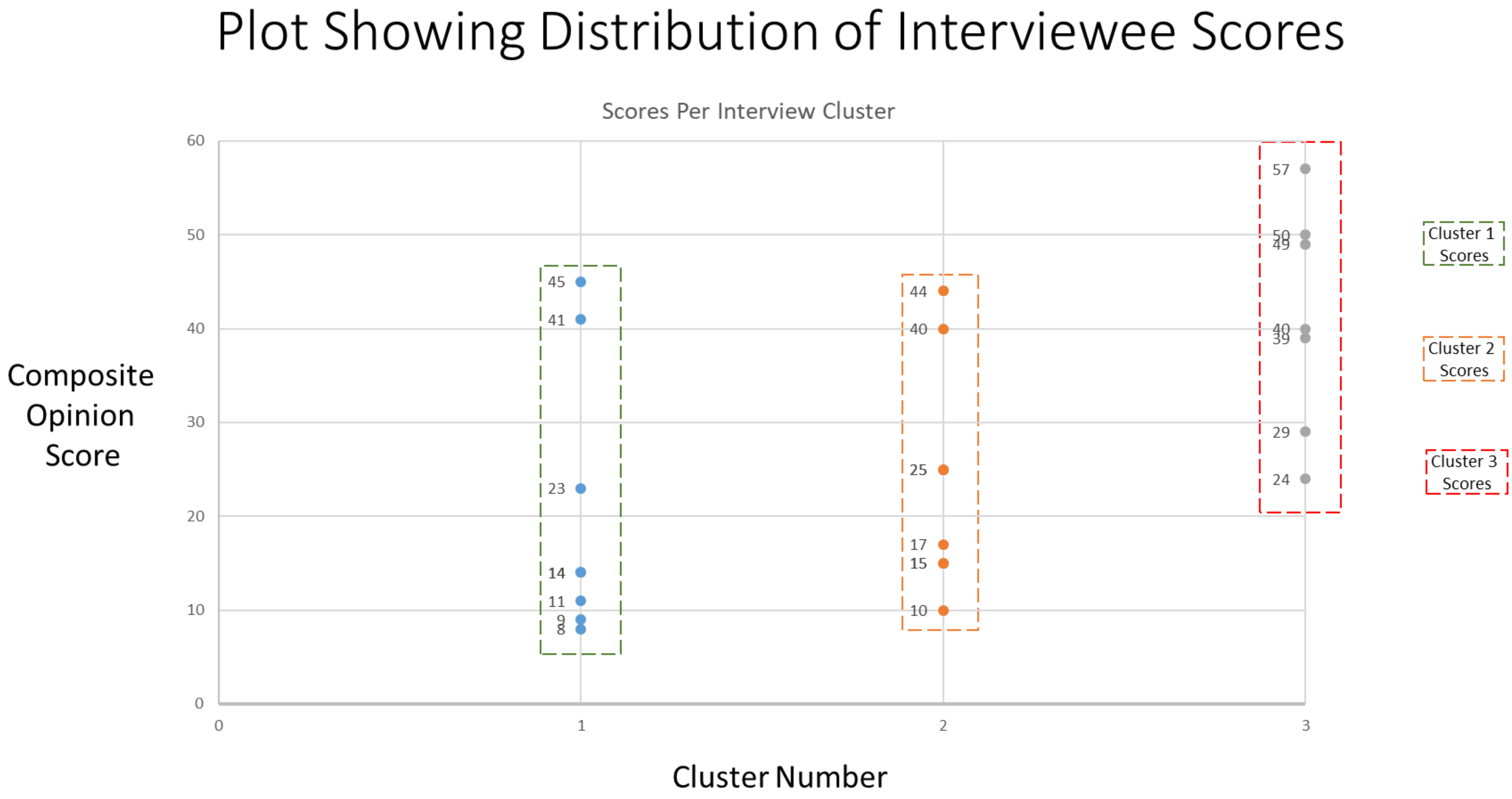
Size of Sample

The issue of 'how many' cases are required is a lively debate and has given rise to a range of opinions. Many of these opinions are dependent upon the exact approach to the research being conducted. What is common to most however, is the term 'theoretical saturation' or the point at which no new themes or knowledge emerge and the definition of this. Some authors (Creswell, 1998) recommend sizes of between five and twenty-five for phenomenological studies and between twenty and thirty for grounded theory studies, while Morse, (1994) has stated at least six for phenomenological studies and up to fifty for ethnographic and grounded theory. Creswell and Plano-Clark (2017) refer to an example study (Ivankova Cresswell and Stick, 2006), which uses an explanatory sequential mixed methods design where an initial quantitative design collected data from 207 current and former students. The significance of this is that Creswell and Plano-Clark, (2017) argue that the important consideration is to collect sufficient qualitative data to develop meaningful themes that help to provide explanations for quantitative results. Ivankova, Cresswell and Stick, (2006) followed their quantitative survey questionnaire with a sample of four qualitative interviews. The divergence of views around sample size thus presents the qualitative (and mixed methods) researcher with a decision about 'how many interviews are enough?' Kiernan and Hill, (2018) when referring to the process of Framework Analysis make the argument that data saturation is a subjective judgement based on the evolving data and that the researcher should exercise judgement as to when theoretical data saturation occurs. Hence the practical application of this is that during data analysis, the theoretical framework constructed during phase 2 of Framework Analysis (Ritchie and Spencer, 2002) should remain constantly evolving and 'live'.

Guest, Bunce and Johnson, (2006) describe their process of achieving data saturation in a methodological paper when performing a study involving 60 interviews across two West African countries. The authors developed a codebook for use between two data analysts based on five parts. Coding agreement between data analysts was then assessed for each third interview using Kappa-scores on double-coded transcripts. The aim was to explore how many interviews were necessary to achieve a sense of thematic exhaustion and variability within the data set. This was achieved by documenting the development of themes after six interviews and then subsequent rounds after every six interviews. The codes used were examined for frequency of use to explore if certain codes had been used primarily in the initial six to twelve interviews and then had never been applied following this, therefore providing a useful audit trail of code application over the course of 60 interviews. Analysis revealed that 109 codes were developed from an initial data set in one of the countries, of which 73% (80 codes) were developed within the first six interviews and a further 20 codes within the first 12 interviews, essentially demonstrating that 92% of codes were developed within 12 interviews. The remaining nine codes were developed over the next 18 interviews. Interview data (n=30) from the second country added a further five codes, none of which were substantive, therefore the authors concluded that, based on their analysis, data saturation had occurred after twelve interviews and that 92% of the codes were prevalent. The remaining 8% of the codes were deemed not substantive and were grouped together as 'other' as described by Gale et al, (2013). This process, however, does provide a useful example of how data saturation may be audited and analysed when conducting a qualitative phase involving individual interviews. The process outlined here was adapted for use in the qualitative phase as it allowed the researcher to audit the code development and usage collectively as a data set and within each individual cluster. The data saturation process and sample size decisions in this phase of the study therefore was an evolving concept, however an initial sample of nine participants from each group was decided (total of 27) in line with the guidance offered by Cresswell and Plano-Clark (2017). Together with representational evidence in graphical format to support this decision, this is presented later in the chapter.

Sample Selection

A maximum variance sample was therefore recruited according to a composite opinion score generated by the survey questionnaire (Appendix). There were many potential cases who were suitable for inclusion in each of the three clusters, however, there were key areas of overlap that the author chose to explore and ultimately to explain. The 'outliers' of the sampling strategy were identified to be the highest and lowest scoring cases from each cluster. These scores are demonstrated in graph 1 and represent the 'extremes' of each cluster. Graph 3.1 demonstrates the three individual clusters (Green Dashed Box = Cluster 1, Amber Dashed Box = Cluster 2, Red Dashed Box = Cluster 3) and the corresponding interviewee scores per cluster, derived from their initial questionnaire.



Graph 3.1. Individual Scores of Interviewee from Initial Questionnaire.

Graph 3.1 shows that Cluster one captured eight interviews of which five interviewees scored very low (8, 9, 11, 14 and 14) in addition to three cases that were within the distributed scores of the other clusters (45, 41 and 23) whereas Cluster three captured seven interviews of which, four cases scored highly (57, 50, 49, and 40) in addition to three cases scoring within ranges of clusters one and two participants, thereby representing a common scoring range or 'middle ground' (24, 29 and 39). Cluster two aimed to capture two interviews where scores were in the 'middle ground' (25 and 25) but also some interviews from both lower (10, 15, 15 and 17) and higher ends (40 and 44) to look for explanatory patterns in the data. These interviews from each cluster were selected as they aimed to select the most outstanding 'successes' and 'failures' related to this topic of interest (Teddlie and Yu, 2007). Hence this may give insight and explanation into why some participants were in different clusters but showed similar scores based on this method.

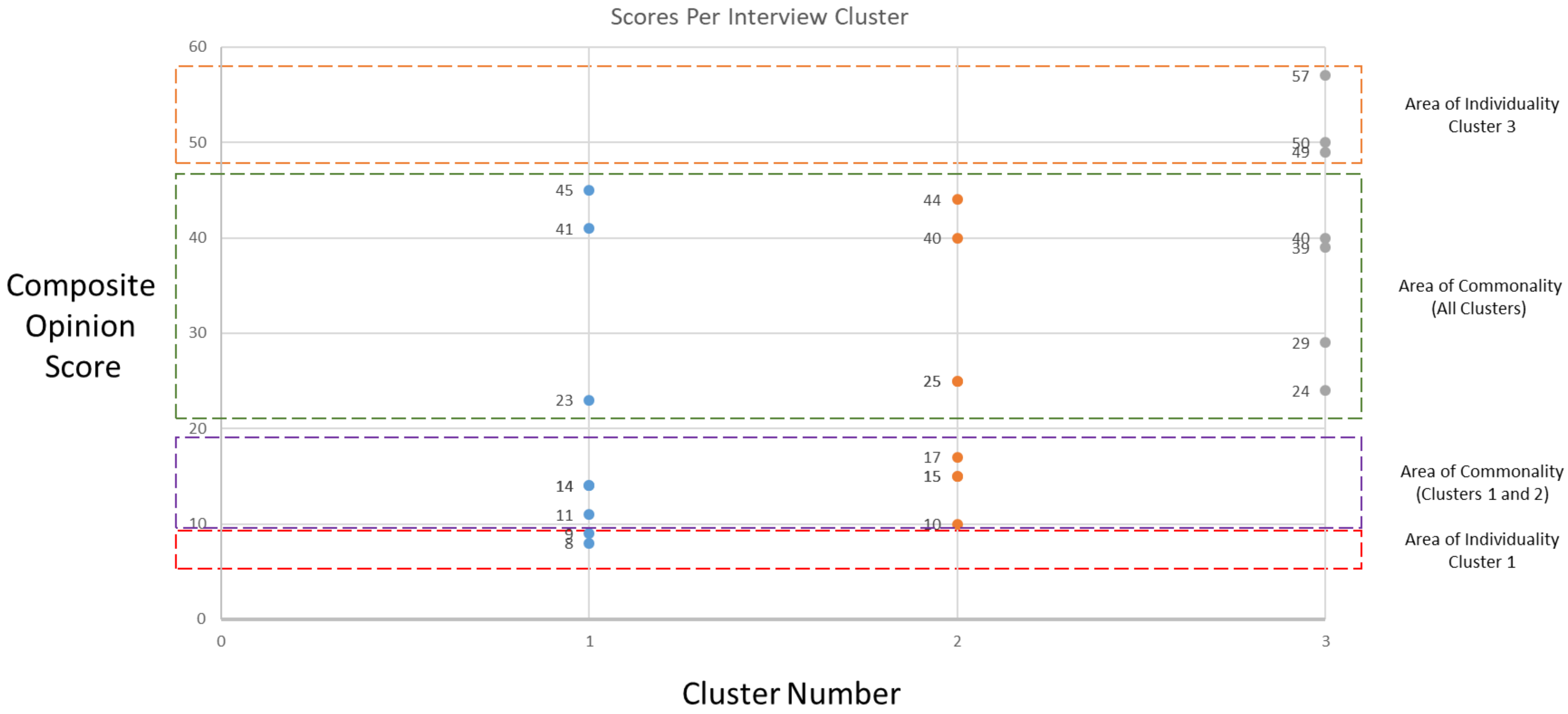
Table 3.1 shows the mean score from each interview cluster and the larger overall cluster from the questionnaire. Mean scores from each cluster closely resembled the mean scores from each larger group cluster from the original survey questionnaire. Although the aim of the qualitative interview sample was to capture a maximum variance sample rather than a representative sample, it transpired that the samples from each cluster were similar to their wider clusters from the survey questionnaire sample.

	Cluster 1	Cluster 2	Cluster 3
Mean Score per Interview Cluster	20.63 (SD 14.6) (n=8)	23.88 (SD 12.3) (n=8)	41.14 (11.82) (n=7)
Mean Score per Overall Cluster	24.57 (SD 10.0) (n=54)	24.54 (SD 10.7) (n=71)	37.68 (SD 8.1) (n=31)

Table 3.1. Mean Interview Cluster Scores and Overall Survey Cluster Scores (Missing: N= 7).

Graph 3.2 shows the distribution of the composite scores across the three clusters. It is clearly demonstrated where areas of individuality exist in both cluster one (red section) and cluster three (amber section) and where areas of commonality exist between all clusters (green section) and areas of commonality exist between clusters one and two (purple section).

Plot Showing Distribution of Interviewee Scores

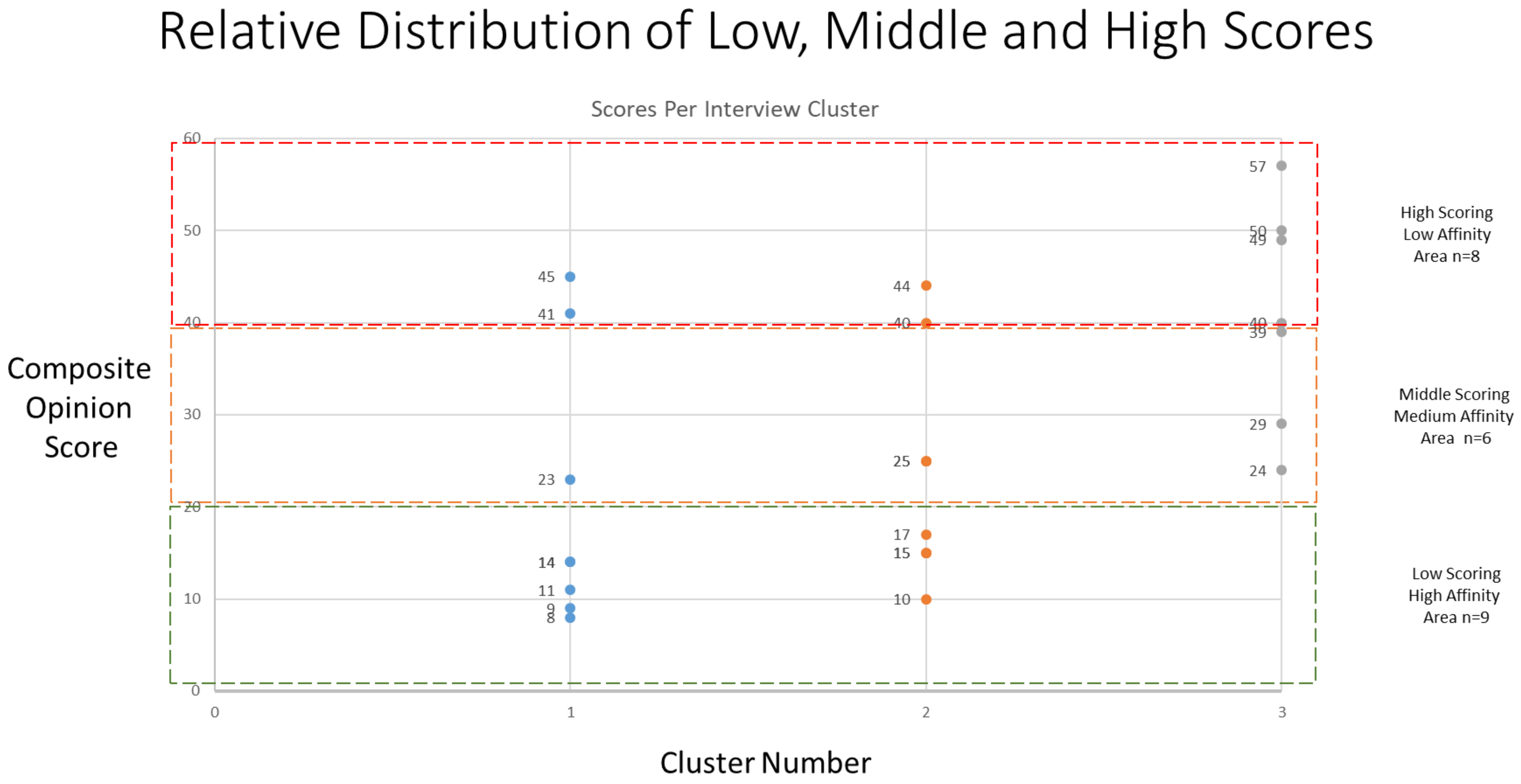


Graph 3.2. Areas of Individuality and Commonality in Interviewees.

Whilst Graph 3.2 shows areas of commonality and individuality, it is important to note that the rationale for the sampling was to address the issue of heterogeneity across the scores to allow for consideration between clusters. Graph 3.2 demonstrates areas of sampling heterogeneity (i.e., areas where scores were recorded for all clusters in grey, commonality between clusters 1 and 2 – purple). This graph aims to demonstrate that participants with similar scores were selected from across the clusters and avoid simply selecting low scoring participants being selected that could give invalid findings. For this reason, interview candidates were selected with the rationale that it was important to consider how high, middle, and low scores compared across the clusters and how in-depth interviews may help to aid the understanding of their mobile technology strategies for learning. Graph 3.3 therefore shows the distribution of the sample with respect to their scores across the domains of 'high scoring, low affinity', 'middle scoring, medium affinity' and 'low scoring, high affinity'. This graph demonstrates the influences of how the sample was selected with a degree of 'overlap' in mind to allow the author to look for explanatory patterns in the data that may aid the understanding of the key influences in their learning and how or if mobile technologies facilitate this.

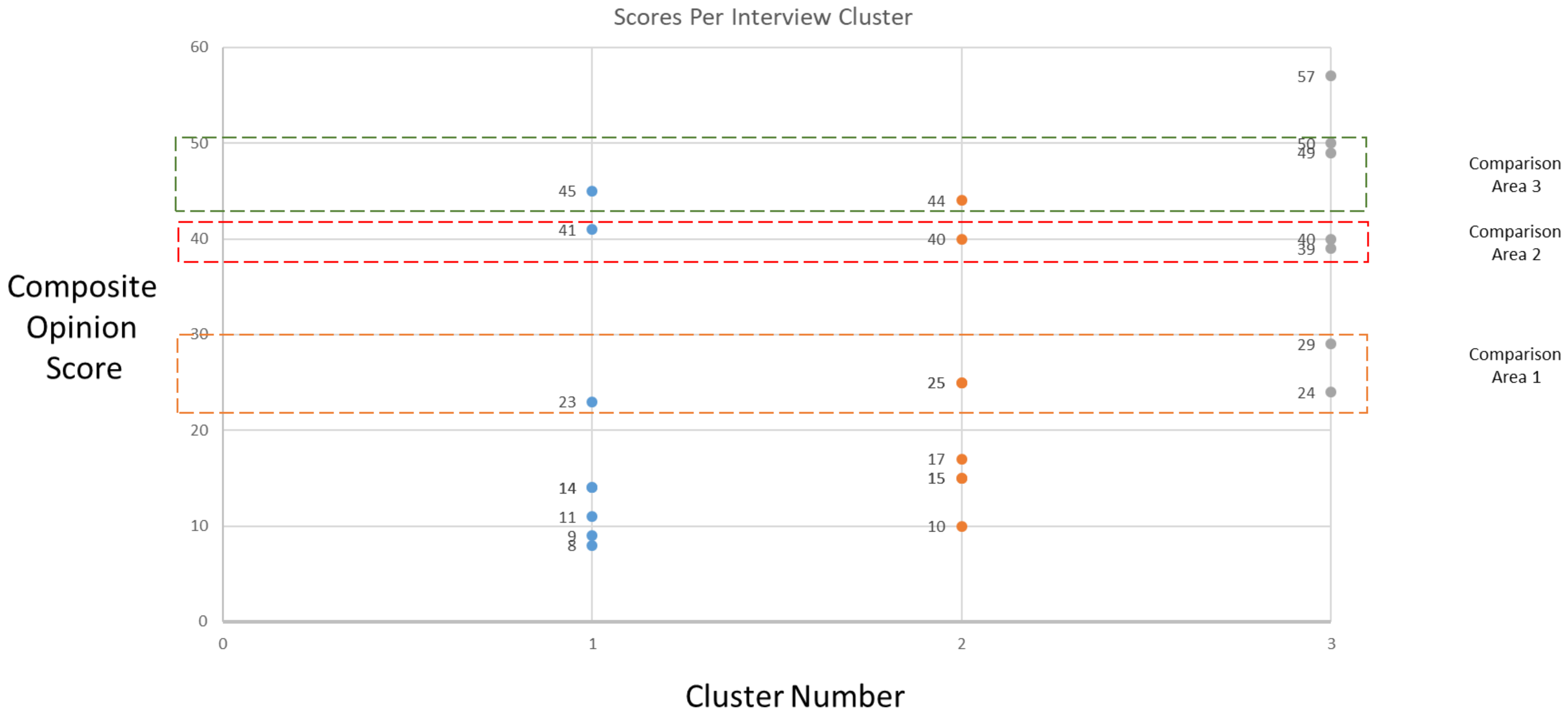
The high scoring, low affinity area, demonstrates eight interviewees across the three clusters who may illuminate why students who seemingly have different attitudes in some aspects of mobile technologies may have shared opinions around the merits of learning using such devices. This sampling approach is mirrored in the middle scoring area where six interviewees across the three clusters may help to illuminate why different clusters may demonstrate shared opinions. The low scoring areas demonstrate only interviewees from clusters one and two, but again will help the author to understand where shared views or different experiences of mobile technologies have influenced their adoption and usage of these in their learning.

Of particular interest are the opinions and experiences of interviewees who have been placed in different clusters, however, show similar opinion scores. These are shown in graph 3.4 and were tagged during the data inputting to NVIVO for cross comparison purposes during data analysis.



Graph 3.3 Score Distribution Showing Spread of Low, Middle and High Scores Across Clusters.

Comparison of Clusters Across Middle and High Scores



Graph 3.4 Areas of Score Similarity Across Clusters.

Data Collection and Interview Procedure.

An interview schedule was developed that was partly grounded in the descriptive results of the survey questionnaire and partly from the research literature. Interviewees were invited via email to attend for an in-depth interview within the University using one of two quiet seminar rooms (approximately 8 feet x 10 feet). The interview schedule was sent to invited interviewees, together with consent forms, information sheets and debrief forms a few days ahead of the interview to help them familiarise themselves with the questions and think about their responses. This also allowed any prospective interviewees to reverse the decision to participate if necessary.

When interviewees had confirmed receipt of these documents and had consented to participate via email, arrangements were made for a mutually suitable date and time. Interviews took place in one of two seminar rooms and were recorded using an audio dictation device that captured the audio in .wav format. Interviewees were invited in no particular order relative to their allocated cluster and were conducted between 6th June 2016 and 7th June 2017. All interviews were conducted by the author and lasted between 20:32 minutes and 48:52 minutes and involved a total of 13 hours and 28 minutes of interview time.

After the initial introduction and welcome to the interview (all interviewees were known to the interviewer), the interviewer summarised the aim of the study and that the views of the interviewer were 'neutral' in that there was no evidence that had explored the influences and experiences of mobile devices on learning in pre-registration Physiotherapy students, hence there were no 'right' or 'wrong' answers. This was clarified further by the author/interviewer (with the aim of minimising social desirability bias and reducing author reflexivity), who stated that they were conducting the research as they were themselves, unsure of the influences, hence interviewees should answer as honestly as possible rather than answer to match perceived opinions of the author. Interviewees were explained why they had specifically been selected to participate in the interviews and were offered a final opportunity to withdraw. Once this was confirmed, the consent form was signed, the audio dictation equipment was set to 'record' and the interview was commenced. The interview schedule was made available to interviewees via email prior to the interviews and was loosely followed to allow the interviewer to probe responses further and allow free expression of opinions and experiences. Interviews were terminated when the interview schedule had been exhausted and the interviewees had been given the opportunity to add any further comments or experiences that they felt were significant to their learning strategies. Interviewees were thanked for their time, and they were asked to read and sign the debrief form. Additionally, the interviewer informed interviewees that verbatim copies of the interview would be sent to them via email, and they were requested to peruse, comment on and return the script electronically with suggested amendments.

Evolution of Interviews.

The process of data collection through interviews was conducted in a non-linear manner. Although the interviews followed the interview guide (Appendix B) the availability of the selected sample did not always coincide with the availability of the researcher hence data collection occurred over a period of 12 months. During this time, there were varying periods of activity, where for example, three interviews could be conducted within 48 hours of each other, or a period of two months would occur where no interviews occurred. The influence of this upon the data collection allowed a period of reflection in which the researcher was able to consider the manner and style of previous interviews. Was the researcher guilty of asking leading or closed questions? Were interviewees answering in a biased manner to appease the perceived views of the interviewer and was the researcher 'missing' any clear messages that were articulated in different narrative styles? Part of this process of reflection was aided by the transcription of interview schedule.

Data Handling and Analysis.

Data was analysed using the Framework method outlined by Ritchie and Spencer, (2002), Ritchie, et al. (2013). This method of data analysis sits at the heart of Applied Social Policy Research, and aims to provide theories, explanations, and insights to social behaviour (Ritchie and Spencer, 2002). This method facilitates the analysis of data to provide solutions or suggestions into social behaviours. It also provides a transparent method that systematically analyses data in a manner that demonstrates trustworthiness. Whilst the interpretation is subjective and open to individual realities of the "inner world" possessed by everyone, the transparency of data analysis should be demonstrable. The influences of mobile technologies upon the learning of the population studied, therefore lend themselves to analysis of this type to gain a deeper understanding of the drivers for engagement with these technologies on both an individual and group basis. What are the individual and common themes that emerge from the narratives studied and what insights does this reveal regarding their behaviour as an individual, sub-group (cluster) and as a wider group? Do these behaviours offer explanations that give rise to solutions for future student behaviour and achievement? Framework analysis provides an excellent data management approach in this regard, as it produces a series of framework matrices in which each case is allocated an individual row, and each theme is attributed an individual column. This enables the researcher to examine cases on an individual basis as well as a thematic basis without losing sight of the raw data (Ritchie et al. 2013). This was important when analysing individual clusters as it allowed the researcher to cross-compare elements such as gender, age etc. that may show patterns across clusters as well as within clusters e.g., do certain age groups behave in similar ways but exist in different clusters?

Transcription.

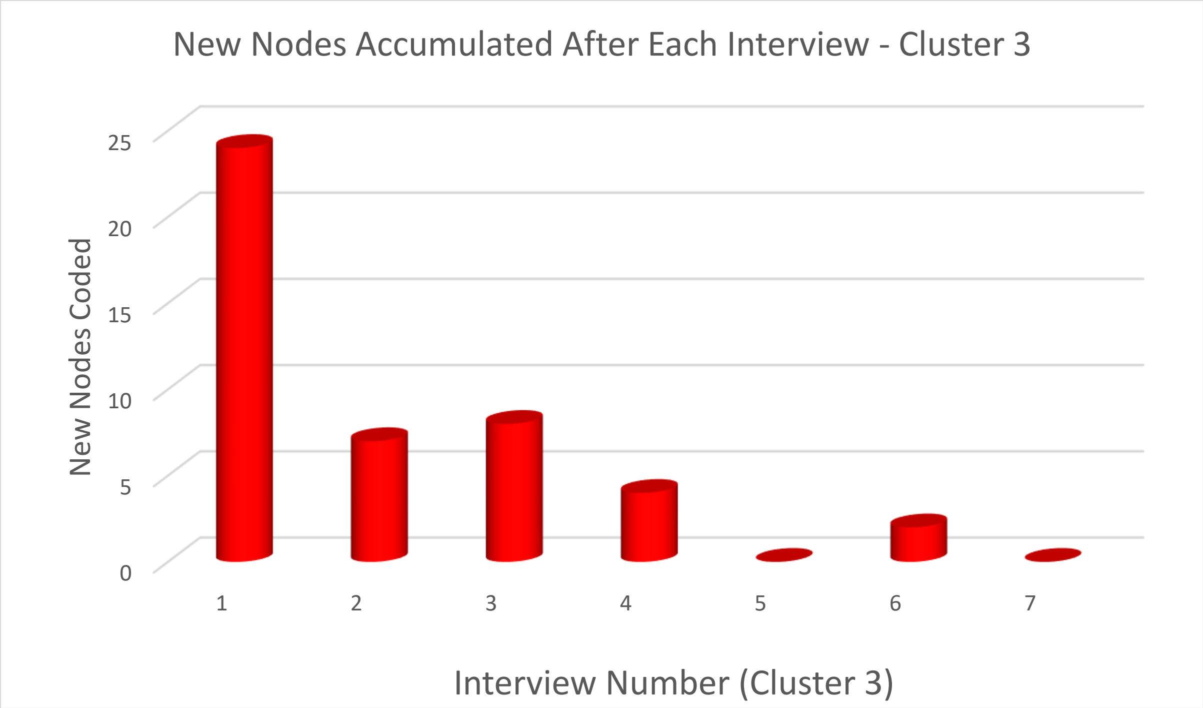
The researcher decided to transcribe all of the interviews personally in an attempt to familiarise and immerse themselves in the data. Audio files were filed and retrieved from a secure network drive and were played at 50% normal speed whilst the researcher transcribed the files verbatim. After completing the transcription, the file was replayed whilst checking the transcript for accuracy and error. Instances where pauses occurred, were identified (…) and any verbal or non-verbal body language demonstrated was identified using brackets e.g., laughter. This effectively meant that after transcription, the researcher had listened to each transcript on four occasions. Brief notes were made following each interview and were linked to the transcript using a 'Linked Memo' within nVivo. Total audio time for interviews totalled 13 hours 28 minutes and 9 seconds and transcription time for all 23 interviews took around 90 hours to complete: average time around 3 hours and 55 minutes per transcription.

Data Saturation.

The aim of data saturation has been explored previously in this chapter, where it was stated that it exists to explore how many interviews are necessary to achieve a sense of thematic exhaustion and variability within the data set (Bunce, Guest and Johnson, 2006). In keeping with their method, this study documented the development of codes for each cluster individually. After six interviews had been conducted in each cluster, codes were examined for frequency of use to explore if certain codes had been used primarily in the initial six interviews and then had been applied more sparingly following these. This provided a useful audit trail of code application over the course of the 23 interviews conducted across the three separate clusters. Analysis revealed that 45 codes were developed in cluster three, of which 53% (24 codes) were developed after the first interview and 43 (95%) after the first four interviews. A further two codes were developed after six interviews essentially demonstrating that 100% of codes were developed within six interviews, hence it was decided that theoretical saturation was likely, however, a further interview was conducted to explore if further codes were produced. The absence of new codes following the seventh interview gave further support that data saturation was likely. Table 3.4 illustrates the development of codes for cluster three and Graph 3.5 illustrates this graphically. This process was repeated for all clusters and showed a similar pattern for each. For clusters one and two, a further interview was conducted (n=8) in light of the larger number of codes initially developed.

	Nodes Following Each Interview	Total Nodes	% Node Development
24	24	45	53.3
7	31	45	68.9
8	39	45	86.7
4	43	45	95.6
0	43	45	95.6
2	45	45	100.0
0	45	45	100.0

Table 3.2. To Demonstrate New Nodes Accumulated After Each Cluster Three Interview.



Graph 3.5 Demonstrates New Nodes Accumulated After Each Cluster Three Interview.

The Framework Method.

The process consists of five distinct stages and was followed according to the stages below.

1. Familiarisation and Coding.

2. Construction of initial framework matrix.

3. Indexing and Sorting

4. Charting

5. Abstraction and Interpretation

Audio files were transferred to a secure network drive and were transcribed verbatim by the author as text file documents. Interview transcripts were imported to nVivo Pro 11.0 software for initial familiarisation and coding.

Interviews were conducted according to consent and availability of the interviewees and lasted between 23 and 51 minutes. Verbatim copies of the transcripts as they were completed, and these were sent to each individual interviewee for comment and any suggested amendments were sent back to the author.

Data Handling.

When transcribed interviews had been verified and validated by the interviewees, they were imported into nVivo Prov11.0. Both audio files and word documents were imported into a 'Sources' folder. A subfolder entitled 'Interviews was created and each of the 23 interviewees was given an anonymous file name. nVivo can display both audio and word files within the viewer window to allow for simultaneous audio and text to be followed.

Stage 1. Familiarisation and Coding.

Transcripts were re-read as part of the familiarisation stage of framework analysis and initial codes were generated from the transcripts. Initially, during the first 'sift' of coding, statements were highlighted and assigned to 'nodes' or 'codes' (hereafter referred to as codes). A brief definition was applied to these codes, allowing the researcher an option to assess for similar definitions and to then merge or collapse similar codes into larger categories as the data analysis progressed. As each code was developed and defined, the importance of a codebook emerged. This was a record of each individual code with a particular definition of the code and instances where the code should be applied. Guest, Bunce and Johnson, (2006) describe the steps in the development of a codebook as consisting of 5 phases, including 1) a brief definition, 2) full definition, 3) when to use, 4) when not to use and 5) example sections of coding. As the codebooks in this study involve a single coder, the development of phases 2-5 were deemed unnecessary and a brief definition of each code was sufficient. The issue of confirmability needed to be considered at this stage as the use of a single coder does give rise to the reflexive nature of coding and individual subjective interpretation of the researcher. The researcher aimed to address this issue by documenting and demonstrating a transparent process of data collection, data handling and analysis with appropriate data verification procedures. Kiernan and Hill, (2018) describes data analysis as inherently a reflexively shaped process. The subjective interpretation of qualitative research data is a unique interpretation, and opinions may differ regarding the actual meaning, however, if the process is transparent, this helps to allow alternate interpretations and demonstrate a degree of scrutiny and confirmability that are open to inspection.

After coding of the first five interviews was completed, codes were organised into three separate nVivo folders to reflect the three clusters. These were entitled 'Cluster One', 'Cluster Two' and 'Cluster Three'. Codes were organised in clusters to allow framework matrices to be developed within individual clusters e.g., within cluster one interviewees, but also an overview was maintained across the clusters to explore patterns of similarity and individuality across all participants. This method will allow the researcher to look for examples of similar influences across clusters that exist with respect to mobile mediated learning, but also what influences and strategies are common to each cluster.

During the initial coding, transcripts were examined line by line and statements were selected on a pragmatic basis according to their perceived level of significance. Further lines of text were then selected, coded, and assigned to a particular code until the coding of the transcript was completed. Where a new code was created, a brief definition of this was created within nVivo for future reference and to allow further additions to the codebook. The pragmatic selection and coding of statements led to multiple coding in some cases.

Statements were examined and were often coded to more than one code due to the nature of the responses. In some cases, a single statement was assigned to several separate codes; as many as six separate codes on rare occasions.

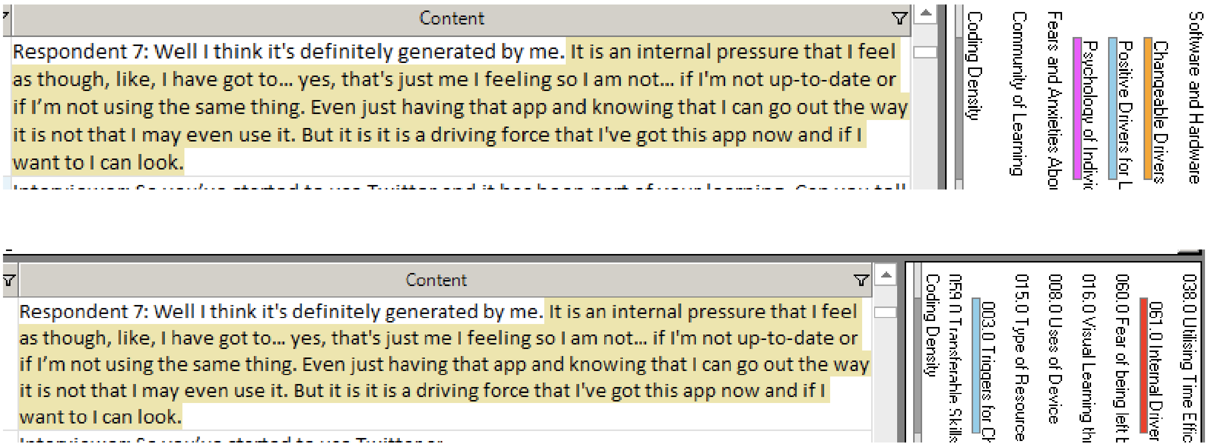


Figure 3.7. Shows an Example of a Text Selection That Has Been Coded to Five Separate Codes.

After each transcript had been coded, the author recorded some thoughts and general impressions about the interview using the ‘memos’ tool within nVivo. Here, some general thoughts about the main points of the interview were recorded. These memos were linked to each interview and contained around 4-5 lines of concise text which summarised these points. Below is an example of one such memo from a cluster three interviewee.

Some good points around the culture of learning within the family and via school that have influenced this participant. Associates a negative learning culture to learning with phone as seen to be a distraction and attached stigmas exist. This links to school where mobiles were confiscated as seen to be an abuse of time and a distraction.

Prefers laptop to phone due to screen size and keyboard access. Also prefers to 'see' various open tabs, whereas they would disappear' on a mobile. Ranks own proficiency as middle of scale. Also prefers to use written based materials for learning.

Example of Linked Memo

This procedure of coding to multiple codes continued for all 23 transcripts. The rationale for this was to allow for a sizeable proportion of each cluster to be coded but to refrain from the full development of a thematic framework that could influence interviews in the data collection. An example of this was to refrain from asking leading questions around any identified themes, rather than interviewees raising the issues that they felt to be important. The interviewer felt that the knowledge of developing themes would have a larger influence over the later interviews and potentially give rise to biased answers. These would be based on structure and phrasing of questions that linked to themes identified by early development of framework matrices. The memos that were linked to each interview did not constitute a development of themes, but merely served as a quick reminder of the interview content and general use for mobile technology.

The advantage of this process was that it developed a rich data set for further analysis; however, it also created an abundance of data that became overwhelming due to the amount of duplicate information within the codes. It became clear at this point that the nature of framework analysis involved a non-linear process and that the stages involved in framework analysis need to be revisited and reflected upon.

After coding of all interviews was complete, each cluster was examined for the number of codes and sources and references within each code. The codes were then organised numerically based on the number of sources within each code. A source was defined as any interviewee within a cluster e.g., cluster one, that had a statement coded to a particular code. Therefore, the minimum number of sources within a code could be one (a single interviewee had a statement coded under that code) and the maximum number could be 8

(Clusters one and two) or 7 (Cluster three). The example below shows 9 sources as a PDF research article had also been coded inadvertently.

Name	Sources
001.0 Learning Strategies	9
002.0 Positive Learning Experiences Using Technology	9
003.0 Triggers for Change	9
004.0 Collaboration	8
005.0 Learning Environment	8
006.0 Social Constructivist eLearning	8
007.0 Social Media Learning	8
008.0 Uses of Device	8
009.0 Barriers to Using Learning Technologies	7
010.0 Learning Experience	7
011.0 Learning to Use Technology Effectively	7
012.0 Non-Purposeful Learning	7
013.0 Quality and Re-assuranc	7
014.0 Transferability between Devices	7
015.0 Type of Resource	7
016.0 Visual Learning through Video	7
017.0 Support Tool	7
018.0 Creating Resources	7
019.0 Traditional Learning	7
020.0 Proficiency with Technology	7

Figure 3.9. Example of Numerical Organisation of Codes.

This process was repeated for Clusters two and three. The rationale for this was to create a framework matrix where the most frequently cited codes (by source) would appear on the left of the matrix and the least frequently cited would be on the right. This would then enable the author to identify more easily the codes where a lesser number of sources had discussed these definitions.

Stage 2. Construction of Initial Framework Matrices.

The establishment of the framework headings were provided by the initial process of familiarisation. The initial codes from each group were merged to provide an overall codebook and were examined for themes. This process of refining and applying was continued and then re-refined and applied until no new codes arose. The process and framework for cluster one consisted of eighty-five codes, clustered into thirteen categories, with a brief explanation for each. Two categories are shown in figure 3.10 to illustrate part of the process for cluster one. This process was repeated for both clusters two and three.

Code	Description
Creation of Resources	
Visual Learning through Video	Does video enable learning?
Creating Resources	Examples of self-creation of learning resources
Producing Effective Notes	What do students do to produce effective learning materials?
Personal Learning Network	How do students interact with resources in a personalised way?
Sound Recordings	Experiences of self-generated audio-based resources
Active Learning	How do students actively engage with mobile tech to create resources

Figure 3.10. Development of a Codebook.

Gale, et al. (2013) suggest comparison of coding labels occur after the initial few interviews have been coded and an agreement on a set of codes be reached. Diagrams may be used to illustrate how codes may be grouped together to demonstrate examples of a collective theme which are then defined more clearly into an initial matrix. After discussions with the supervisory team, the codes were then re-examined, and conceptually related codes were grouped together due to the similarities in the codes that they captured. Four emergent themes were identified (development of clinical skills, expeditious learning, barriers and distractions, support tool). The use of priori themes is fully accepted by Ritchie and Spencer (2002) to be part of the Framework Approach whilst also reflective that new and unanticipated themes may also arise in this flexible approach to data analysis.

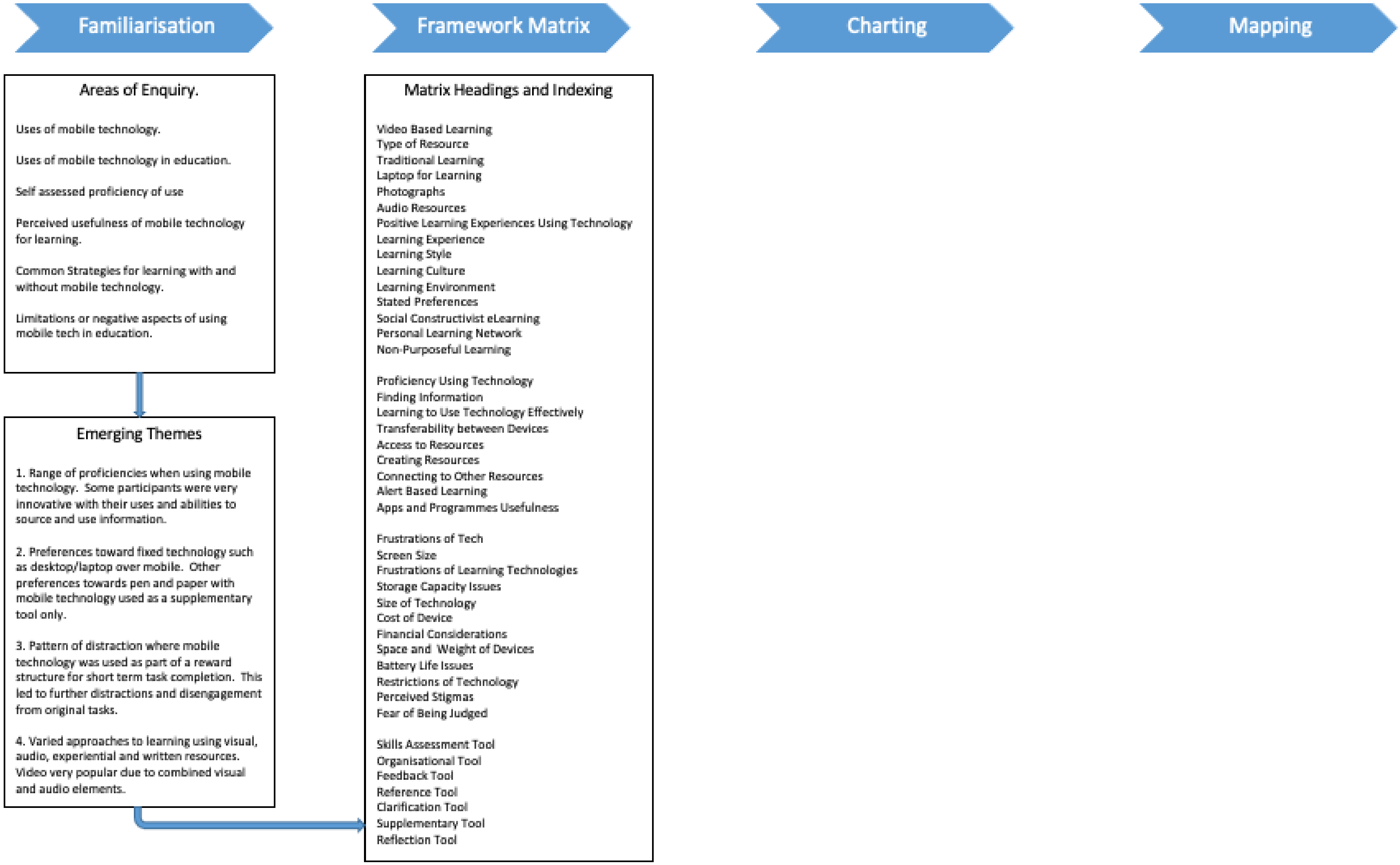
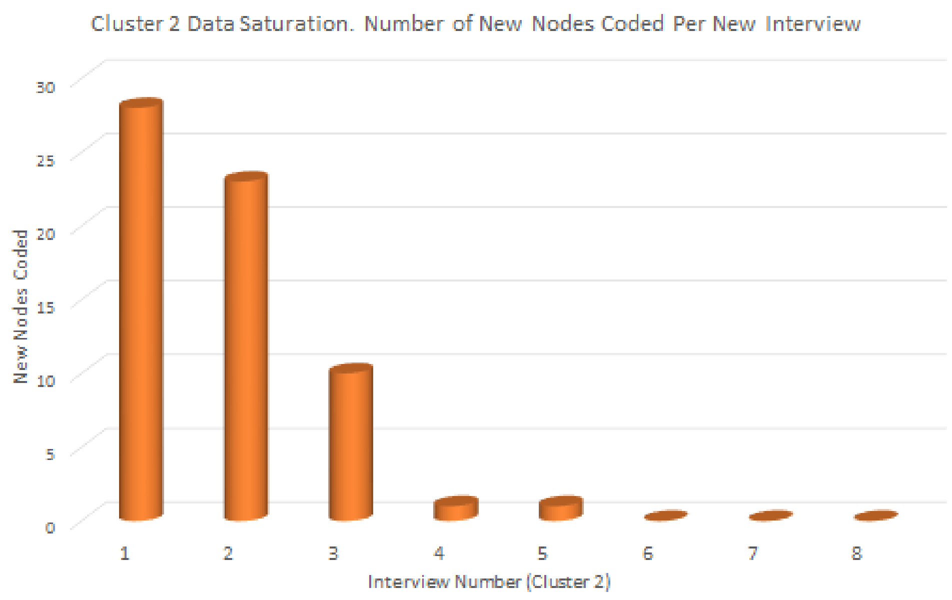


Figure 3.11: Development of Framework and Index.

Stage 3. Indexing.

Data from each participant was indexed and continued until data collection was completed. As this is a reflexive process, data saturation was reassessed by examining the coding that occurred at the end of each cluster. The diagram below shows details for group (cluster) 2 and likelihood that theoretical saturation was achieved. Cluster three has been previously outlined, however the diagram below shows a similar process but where many more codes had been used initially.



Graph 3.6 Demonstrates Data Saturation Process After Each Cluster Two Interview.

Stage 4. Charting.

This step in Framework Analysis involves ordering the data into the relevant area of the framework matrix to form a chart. Text from the data was labelled according to the index and organised into charts using headings from the framework box shown in figure 3.11. As the text was already well-ordered because of the coding and familiarisation stage, the charting of data was relatively straight-forward. Ritchie, et al. (2013) comment that this stage may not be undertaken if data is well-ordered. A degree of refinement was however necessary as codes and data extracts with similar meanings were merged into bigger categories and re-applied to the initial framework matrix. Charts were exported from nVivo to Excel, printed, and data summaries applied to each theme and participant. This enabled a more structured approach to the mapping and interpretation stage as data could be managed from these shortened summaries. The charting stage is outlined in Figure 3.12.

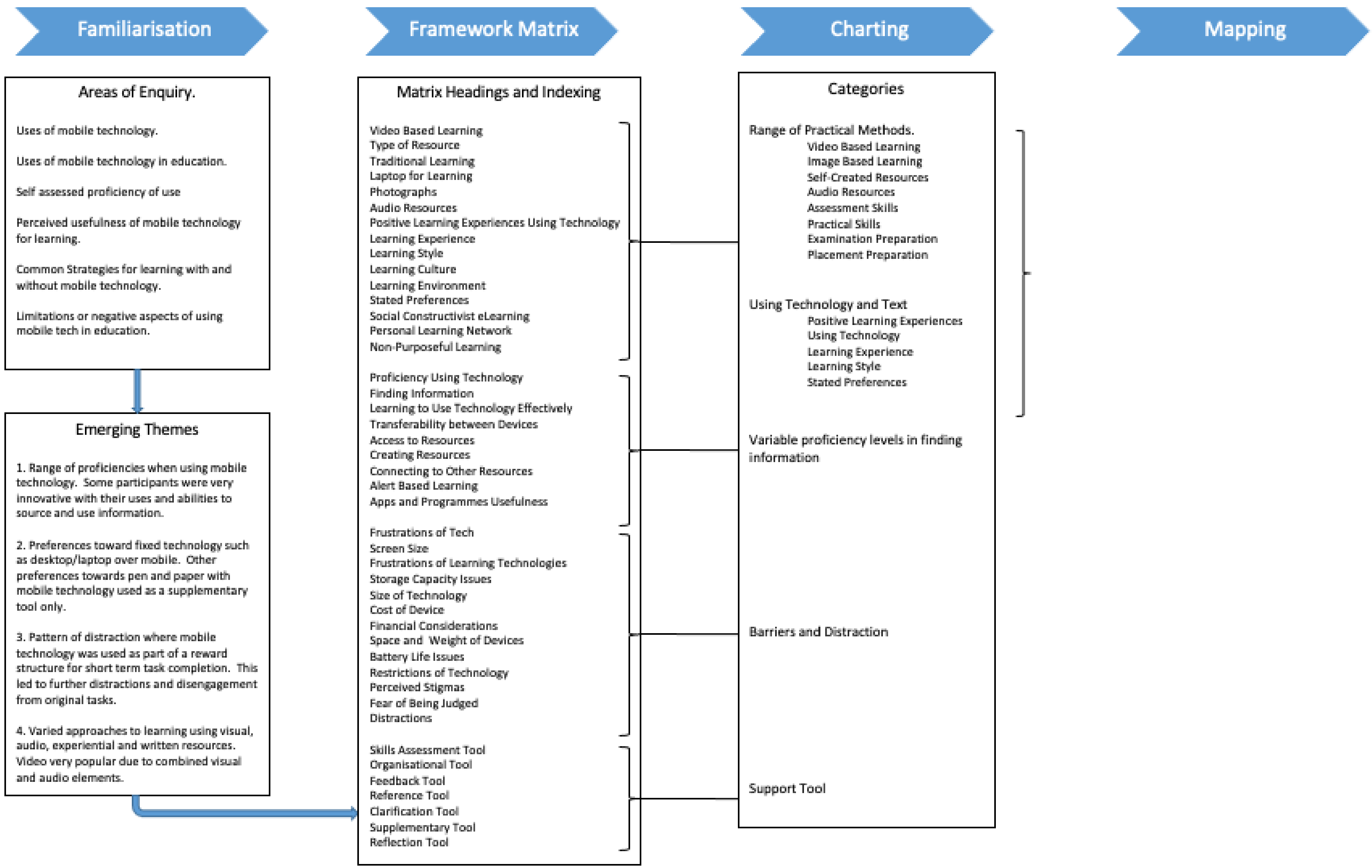


Figure 3.12: Charting of Data.

Stage 5. Mapping and Interpretation.

As data analysis progressed through the stages of framework analysis, it became evident that clear themes had emerged. The wide-ranging learning strategies experienced by pre-registration physiotherapy participants developed as their competence and digital literacy skills improved. Some of the digital literacy skills developed as a direct consequence of engaging with technology and devising solutions to some of the frustrations and barriers that presented themselves. The ability to solve these problems in some ways dictated the level of literacy that participants were comfortable with and strove to improve. This engagement with technology then played a role in the level of support that technology offered as some participants were able to use creative ways to use mobile technology. Figure 3.13 shows the development of the interpretation phase from the previous charting of data and how the final theme of 'developing clinical skills' was developed. Other themes are not shown in this diagram but will be developed during this chapter.

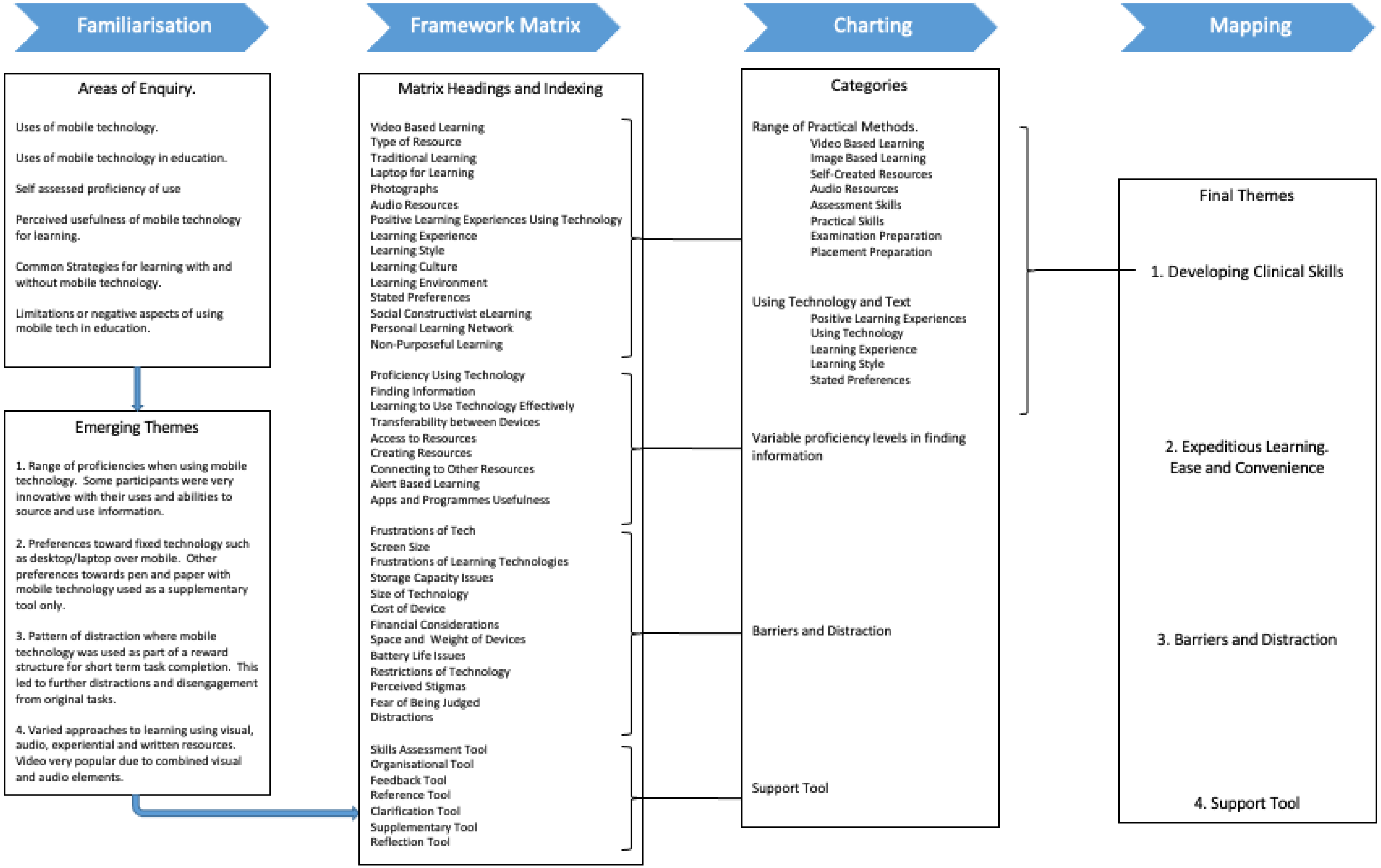


Figure 3.13. Development of Clinical Skills Theme.

Chapter 4. Results

The previous chapter outlined the research philosophy that guided this study and the methodology that has driven the data collection processes. Aims of the main study/cluster/factor analysis and specific hypotheses for the quantitative study are stated or re-stated separately, later in this chapter. The descriptive results will then be presented, followed by a description of the consistency, reliability, construct, and discriminant validity of the questionnaire. A description of the cluster analysis procedures will be given that demonstrate how the survey questionnaire was used to provide a sample for the qualitative phase of the study. Finally, the groups produced by the cluster analysis will be analysed for any significant differences of opinion with respect to the questionnaire opinion statements and hypotheses accepted or rejected. These results aim to provide a deeper understanding of the influences that mobile technology has on the learning behaviours of pre-registration Physiotherapy students and what drivers exist that dictate these behaviours.

The data collection procedures for the qualitative phase will also be described, together with details of the five steps involved in the framework analysis. A transparent process will describe how the main themes of the analysis were derived.

Using the online Survey System power calculator, a sample size calculation returned an ideal sample size of 140 based on 95% confidence intervals with a population size of 220 (Current Northumbria Students at that time) and a margin of error of 5% as recommended by Burmeister and Aitken, (2012). A 15% drop out rate was factored in and hence an overall sample of 161 was targeted. Survey questionnaires were completed by 163 subjects, and were collected, coded and analysed using SPSS for Windows version 22.0. The 31-point questionnaire was double data entered into 2 data sheets and these were compared to highlight any inputting errors. These errors were corrected following analysis to produce a master dataset for analysis.

Each data entry was given a number and a second data set was used to identify the names associated with the data numbers. These data sets were both stored on Staff University Storage Servers that were password protected and held on separate drives to student University Servers. Access to names and data numbers was restricted to the PI only.

Descriptive Statistics were used for the study population with respect to demographics, year and level of study, previous academic background. Descriptive statistics were given as mean and standard deviation for continuous variables and mode/median and interquartile ranges for categorical and ordinal variables.

Main Questionnaire Reliability

As part of the pilot questionnaire, participants were asked to rank a series of 11 questions designed to explore how participants used their mobile devices. These were concerned with using the device as a storage unit, an information access tool to enhance knowledge and understanding, an analysis and application tool, a creative resource tool, an appraisal tool or a supplementary learning tool. Questions were phrased as statements and the participants were asked to rate these on a 5-point Likert scale ranging from 'strongly agree (ranked 1) to strongly disagree (ranked 5). Questions were assessed for internal consistency using Cronbach's Alpha statistic. A reliability co-efficient of r=0.70 was, as with the pilot study, set as the acceptable co-efficient value for this phase of questions. Initial Cronbach's Alpha scores demonstrated an overall r value of 0.606

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.606	.839	11

Table 4.1. Cronbach's Alpha Reliability Statistics for 11 questions using 5-point Likert scale.

Inter-item correlations demonstrated the lowest r values of -.044 (minus 0.44) between 'Used to convert dead time to productive time' and 'Used to judge and appraise new knowledge". Figures of 0.20 and above have been quoted as acceptable correlations for Inter-Item correlations, hence items demonstrating correlations of .20 or below with other items were removed from the questionnaire. The highest Inter-Item correlation was 0.687 between 'Used to supplement existing learning' and 'Used to improve current knowledge'. Item total statistics demonstrated that with removal of the 4 lowest correlated items, each consistently showing inter-item correlations below .20 a Cronbach Alpha value of 0.889 could be achieved, thus satisfying reliability requirements.

Reliability Statistics	
Cronbach's Alpha	N of Items
.889	7

Table 4.2. Revised Cronbach's Alpha Reliability Statistics for seven pilot questions after removal of lower correlated items.

Item-Total Statistics				
Attitude Statement	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I use my device as a primary source of learning	15.0189	27.134	.612	.882
I find it useful to store and record notes	15.5283	25.523	.644	.880
I use my device to access new and unfamiliar knowledge	16.5283	28.562	.700	.874
I use my device to improve current knowledge	16.4151	26.555	.738	.867
I use my device to assess my performance and skills	15.1698	27.721	.579	.885
I use my device to supplement existing learning	15.9245	24.994	.828	.854
Mobile learning helps me to link to other types of information that aid understanding	16.3585	26.388	.737	.867

Table 4.3. Revised Cronbach's Alpha Reliability Statistics for 7 pilot questions showing no further improvement with removal of further items.

Following the pilot questionnaire, revisions were made to the four questions that had been removed and an additional four questions were included that explored the competency of use and training needs with mobile devices. After inclusion of the four revised questions and four 'new' questions, the survey questionnaire was retested for internal consistency and a revised Cronbach's Alpha was calculated based on these fifteen items.

Reliability Statistics	
Cronbach's Alpha	N of Items
.813	15

Table 4.4. Cronbach's Alpha Reliability Statistics for 15 questions after revision of 4 questions plus introduction of 4 'new' questions.

One item demonstrated an item-total correlation of .094 and hence was removed from the analysis, which elevated the Cronbach's Alpha statistic to 0.842, thus satisfying the acceptable co-efficient value for these items.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Use to convert unproductive time into productive time	37.6074	80.561	.094	.842

Table 4.5. Item-Total Statistics for 1 question showing value below .20 and adjusted Cronbach's Alpha Co-efficient following removal of this item.

Reliability Statistics	
Cronbach's Alpha	N of Items
.842	14

Table 4.6. Revised Cronbach's Alpha Reliability Statistics for 14 questions after removal of lower correlated items.

Results of Pilot Study Descriptives.

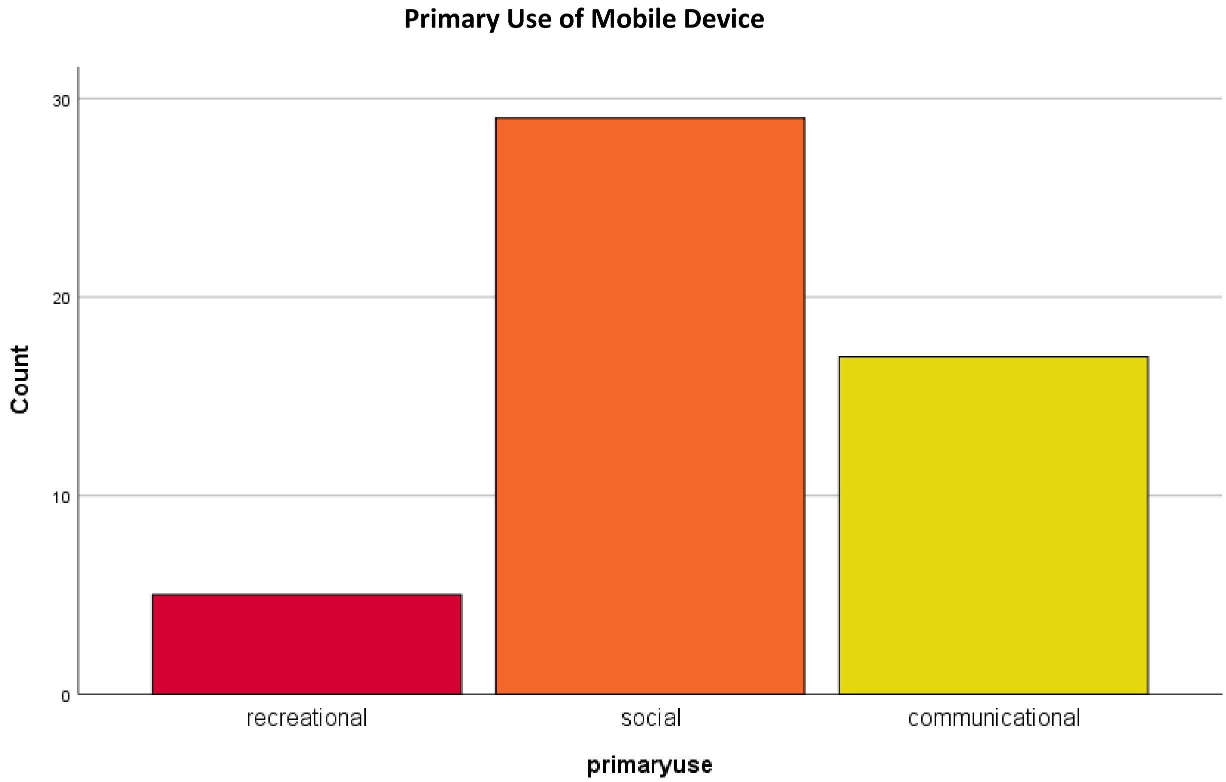
The pilot study consisted of 53 participants from three cohort groups across two professions (2x BSc (Adult) Nursing and 1x Operating Department Practitioner (ODP) group). These are detailed below. Male: Female ratio was approximately 1:4. A higher number of male participants were recruited from the ODP group, with only 1 male participant drawn from the other 2 professional groups. The higher percentage of female students and average age in this sample is in keeping with the higher percentage of female students seen in Physiotherapy students and represents a similar mean age for physiotherapy students.

The average age of the participants was 25.5 years with the female participants being slightly above the mean age (26) when compared with male participants (23.2). The previous academic background of the participants was largely drawn from three routes. Just under half of the participants had completed 'A' Level study prior to their current degree, with around 30% previously completing Access courses. A smaller percentage (15%) had completed a degree qualification prior to their current degree. Pilot study recruits were drawn from Year 1 and Year 3 students. It is a limitation of the pilot study that year 2 students were not included and will therefore be included in the main study to give a representation across the 3 years of degree level study. Pilot data shows that all participants own at least one mobile device (smartphone) however, just below half of the participants also owned a tablet. A smaller number of participants owned iPods (19%) or smaller 7-inch tablets (2%) (known as phablets).

		Frequency (%)
Gender	*Female*	*43 (80%)*
	Male	*10 (20%)*
Year of Study	*Year 1*	*23*
	Year 2	*0*
	Year 3	*30*
Academic Background	*A Level or equivalent*	*26*
	Access Course	*16*
	Previous Degree	*8*
	Previous Diploma	*2*
	Other	*1*
Profession	*Adult Nurse*	*22*
	Operating Department Practitioner	*23*
	Learning Disability Nurse	*8*
Type of devices owned	*Phone*	*53 (100%)*
	Tablet	*26 (49%)*
	iPod	*10 (19%)*
	Phablet	*1 (2%)*

Table 4.7 Results of Pilot Study Descriptives.

The primary use for the mobile device (mobile phone) was for social uses e.g., Facebook. The pilot study demonstrated that the question was ambiguous as some participants interpreted social and communication uses to be very similar. This was noted with the intention to make this question more specific and clearer during the brief to main study participants. Social uses referred to accessing social media sites for browsing purposes rather than communicational purposes. If these sites were used to communicate e.g., direct / instant messaging, then this should be recorded as communicational uses. Recreational uses included using a smartphone to access games and puzzles etc.



Graph 4.1 Primary Use of Mobile Device

The descriptive results established that all participants own at least one mobile device (mobile phone) and that around 50% also own a mobile tablet. The primary uses for mobile devices were social and communicational.

The pilot study established an acceptable level of consistency (Cronbach Alpha = 0.842) for 14 opinion-based questions and can now be used for the main study. Four questions were reworded, and four questions were added to the questionnaire following the initial analysis. One question was removed from the questionnaire due to perceived ambiguity. The administrative plan was found to be a robust method and allowed sufficient time for questionnaire completion. Statistical procedures revealed a similar demographic as seen in a cohort of physiotherapy students and thus the survey questionnaire was shown to be a consistent and reliable tool and could be used for the main study, where more detailed results will be described.

Sample Population

Table 4.8 shows the sample demographics of the group. The overall mean age for the respondents was 23.2 with ages ranging from 18-45. It is shown that the sample consisted of 65% females and 35% males.

		Frequency (%)
Gender	*Female*	*106 (65%)*
	Male	*57 (35%)*
Mean Age	*Overall*	*23.2*
	Female	*22.9*
	Male	*23.7*
Year of Study	*Year 1*	*79*
	Year 2	*40*
	Year 3	*44*
Academic Background	*A Level or equivalent*	*87*
	Access Course	*14*
	Previous Degree	*40*
	Previous Diploma	*16*
	Other	*6*
Number of Devices Owned	*1*	*57 (35%)*
	2	*75 (46%)*
	3	*29 (18%)*
	4	*2 (1%)*
Type of devices owned	*Phone*	*163 (100%)*
	Tablet	*89 (55%)*
	iPod	*39 (24%)*
	Phablet	*3 (2%)*

Table 4.8. Sample Demographics of Main Study Participants.

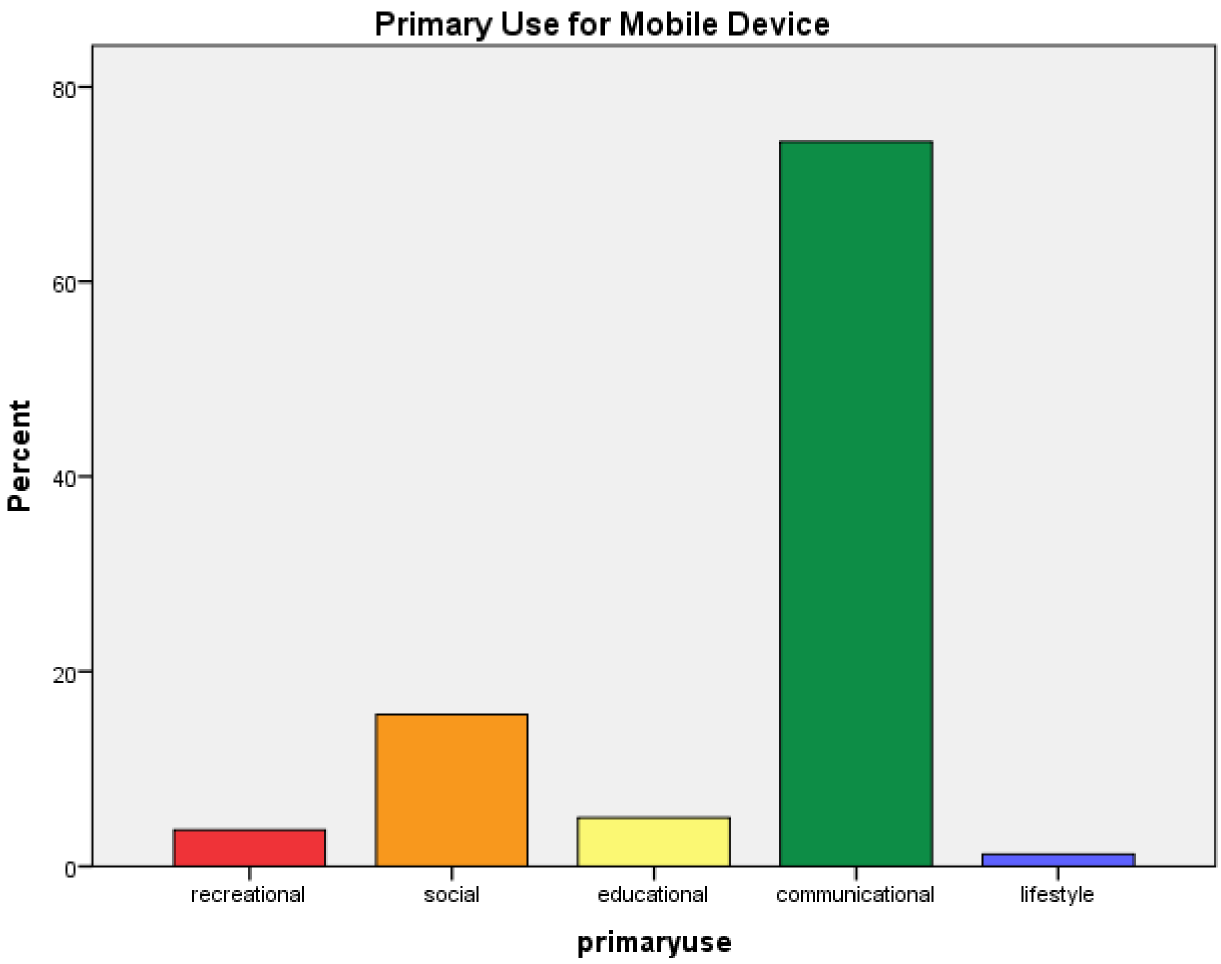
The academic background of the participants prior to University attendance ranged from 'A' Level/equivalent entry e.g., Scottish Higher, Irish Leaving Certificate, Access course, previous Diploma to completion of a previous degree. There was a range of responses to this, with over 50% of the sample entering University direct from ‘A’ level study. Table 4.8 shows the demographics of the male and female populations prior to attendance at University.

The sample was distributed to all three undergraduate years within the BSc Physiotherapy programme, plus both years one and two from the MSc Physiotherapy programme. The highest proportion of students were from Year 1 (48.5%), with smaller but similar percentages from the remaining Year 2 and 3 students.

The questionnaire examined how many devices were owned by participants and demonstrated that 100% of the sample possessed at least one device. This was a mobile phone, but most participants also possessed an additional device. Most respondents possessed at least 2 mobile devices, which tended to be a mobile phone and a tablet. However, various combinations existed, with 19% possessing three or more devices, however a significant gender difference was noted with 23% of the female participants owning three or more devices compared to 12% of male participants (p=0.004). Data in all other variables showed no significant difference between female and male participants. Laptop computers were not included as a mobile device due to their size and weight. It is acknowledged that smaller lightweight laptops were available, however laptop weight at this time was commonly 5-8 pounds (2 - 3.5kg) and dimensions of 15 inch (38cm) were not uncommon.

The other types of mobile devices were tablets (dimensions of greater than 7 inch), phablets (smaller 5-7-inch devices that possess the ability to combine the size and format of tablets and phones such as, Galaxy Note) and iPods. The popularity of these devices was variable with tablets being owned by 55% of the sample, iPod owned by 24% and phablets being owned by only 2%. Table 4.8 gives details of the percentage of respondents who were in possession of these devices.

Most respondents indicated that the primary reason for having a mobile device was as a communication tool (N=119, 73%), however 16% used their device as a social network tool (N=25), 4% as a recreational tool (N=6), 1% as a lifestyle tool (N=2) 1% exhibited no preference (N=3) and 5% as an educational tool (N=8). Graph 4.2 demonstrates most respondents use their primary device for communication purposes.



Graph 4.2. Primary Use for Primary Mobile Device

Main Questionnaire Validity, and Descriptive Results.

The validity of a questionnaire is more difficult to establish than the reliability (Kember and Leung, 2009). The construct and discriminant validity of the questionnaire was tested using a factor analysis, often regarded as the most important method (Kahn 2006). The internal consistency of 0.842 does provide some support for the construct validity of the measure, however, a single study cannot establish construct validity (Peter, 1981) and is an ever-extending process (Cronbach, 1971). The factor analysis will establish which questions load together as separate constructs (by number at this stage) and the discriminant validity will test if the constructs measure separate items. Therefore, the process and results below represent initial steps in a continuing process and the scores obtained perform as the construct is postulated.

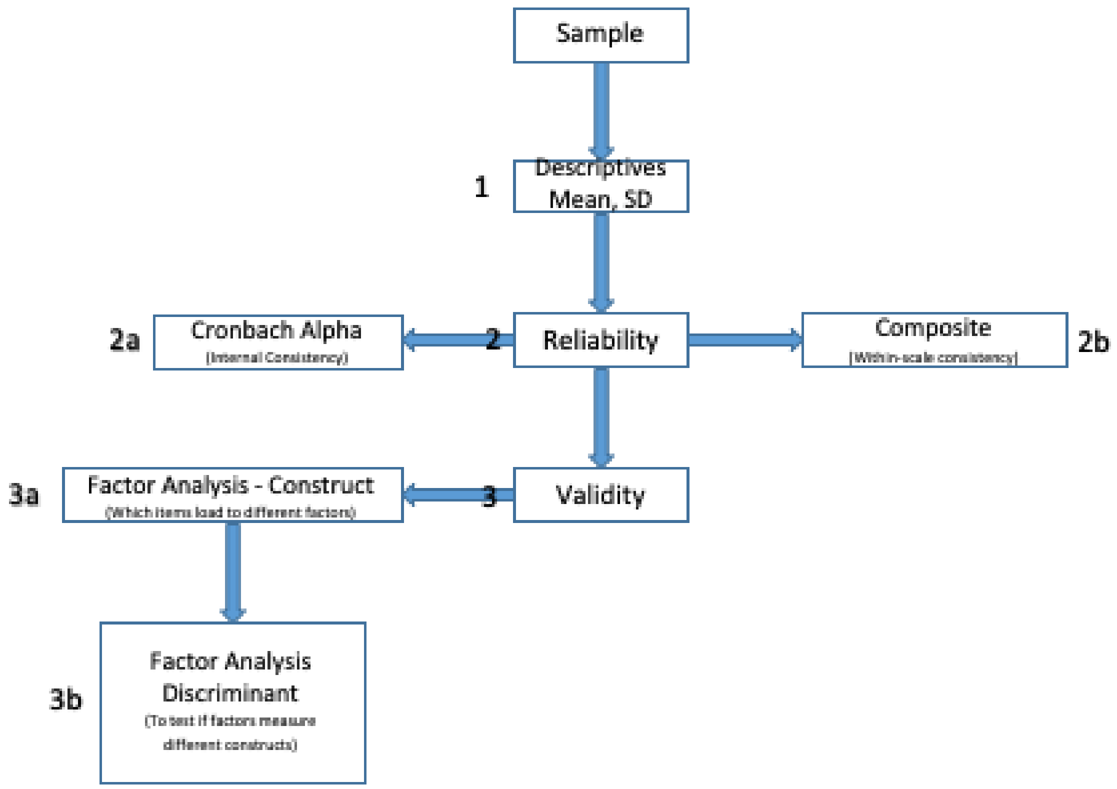


Figure 4.1 Reliability and Validity Data Analysis Procedure for Questionnaire.

Construct Validity

The number of data items and the sample were tested using the Kaiser-Meyer-Oikin (KMO) and Bartlett tests of Sphericity. These tests reveal if factor analysis is appropriate. A value above 0.60 is meaningful for the KMO test (Tsai and Liu, 2005). The KMO was calculated at 0.841 indicating that the co-efficient appropriation was sufficiently high.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.841
Bartlett's Test of Sphericity	Approx. Chi-Square	918.983
	df	91
	Sig.	.000

Table 4.9. KMO and Bartlett tests of Sphericity showing Factor Analysis to be appropriate.

The Bartlett's test of Sphericity demonstrated a value of 0.000 and showed that factor analysis was appropriate for the 14 variables in the questionnaire that measured attitudes. Eigen values above 1 were factored and the factor load was set as a minimum of 0.30 following a Varimax rotation analysis to suppress small co-efficients that were deemed unmeaningful. Literature suggests that the value of this should be between 0.30 and 0.40 (Johnson and McClure, 2004; Tsai and Liu, 2005).

Three factors were found in the questionnaire survey habits. The relationship between the factor variables and the strength of the factor structure scale dictates that the higher the variance, the stronger the scale. Values are considered high if they are above 0.8 or greater (Velicer and Fava, 1998). The variance from these three factors was estimated at 59.8%, however, due to the difficulty in achieving high percentages within social science research, a value between 40% and 60% is considered acceptable (Namlu and Odabast, 2007; Costello and Osbourne, 2005). The factors accounted for 38.8%, 10.9% and 10.4% of the variance respectively. Table 4.10 below shows the items included in the factors after the Varimax rotation was applied.

Component	Eigen Value	% of Variance	Cumulative %	Total *	% of Variance *	Cumulative % *
1	**5.390**	**38.497**	**38.497**	**5.390**	**38.497**	**38.497**
2	1.525	**10.895**	**49.391**	**1.525**	**10.895**	**49.391**
3	1.459	**10.419**	**59.810**	**1.459**	**10.419**	**59.810**
14	.215	**1.532**	**100.00**			

* Extraction Sums of Squared Loadings

Table 4.10 Demonstrating 3 Factors Or 'Constructs' from A Total Of 14 Opinion Questions.

The three factors found because of factor analysis were assessed and considered before titles were applied to these. The three factors or subscales were then named and can be grouped together as specific sub-sections of the scale. The rotated component matrix table below shows which factors were loaded together to produce subscales of the questionnaire.

QUESTION	**FACTOR 1**	**FACTOR 2**	**FACTOR 3**
I use my mobile device as my primary source of learning on my course/programme.	.688		
I use my device(s) to challenge my existing ideas by considering other arguments from relevant websites, feeds etc.	.553		
I find it useful to use my device(s) to research new and unfamiliar ideas introduced at university.	.688		
I use my device(s) to challenge and clarify my existing ideas around concepts learned at university.	.731		
I use my device(s) to improve current knowledge by accessing learning resources e.g., professional journal articles, YouTube videos, relevant websites, Social Media feeds e.g., Twitter	.721		
I use my device(s) to supplement my existing learning.	.738		
Mobile learning helps me to make links to types of information and helps connect these together e.g., a resource (e.g., web-site, YouTube video, Twitter feed, Facebook link) may have a link or links to other learning resources, e.g., YouTube etc. that aid my understanding of a course concept	.709		
I feel confident that I am equipped to use mobile devices to effectively facilitate my learning	.688		
I use my device to create audio visual resources e.g., video		.830	
use my device(s) to create documents to assist reflection and organisation e.g., lecture/seminar notes, assignment plans, Gantt charts		.509	
I find it useful to use my device(s) to record/store notes from university		.498	
I use my device(s) to assess my performance and skills e.g., by video capturing and analysing my performance of skills.		.826	
I would like to see sessions that encourage the use of mobile learning within taught sessions in university			.913
I would like to see sessions that demonstrate the uses of mobile learning within taught sessions in university			.881

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 5 iterations.

Table 4.11 Demonstrating Which Questions Were Associated with Which 'Constructs' (From The 14 Opinion Questions).

Discriminant Validity

Principal Component Analysis Rotation Method: Promax with Kaiser normalisation was performed to establish discriminant validity of the factors produced in the questionnaire. Pattern Matrix values were exported from SPSS to Excel for analysis and average loading was calculated for the three factors. Discriminant validity was established if the variance extraction figure was greater than the correlation square for each of the factors. Table 4.12 below, demonstrates the results of the component analysis calculations.

Discriminant Validity	Variance Extracted	Correlation (Between Factors)	Correlation Square	Discriminant Validity Established
Factor 1	**0.506**	**0.393 (1+2)** **0.388 (1+3)**	**0.154 (1+2)** **0.114 (1+3)**	**Yes** **Yes**
Factor 2	**0.423**	**0.393 (1+2)** **0.177 (2+3)**	**0.154 (1+2)** **0.031 (2+3)**	**Yes** **Yes**
Factor 3	**0.826**	**0.388 (1+3)** **0.177 (2+3)**	**0.114 (1+3)** **0.031 (2+3)**	**Yes** **Yes**

Table 4.12. Demonstrating Establishment of Discriminant Validity Of 'Constructs.'

The three loaded factors were considered, assessed and named as will be shown following presentation of the results.

Factor 1 Results

Consistency, Reliability Extraction and Factor Loading values Relating to Factor 1	Mean	SD	N	Cronbach A	Composite Reliability	Average Variation	Extraction	Factor Loading
I find it useful to use my device(s) to research new and unfamiliar ideas introduced at university.	**2.23**	**0.99**	**163**	**.824**	**.879**	**0.426**	**.555**	**.688**
I use my mobile device as my primary source of learning on my course/programme.	3.47	**1.17**	**163**	**.832**	**.879**	**0.426**	**.501**	**.688**
I use my device(s) to challenge and clarify my existing ideas around concepts learned at university	**2.56**	**1.09**	**163**	**.819**	**.879**	**0.426**	**.627**	**.731**
I use my device(s) to improve current knowledge by accessing learning resources e.g., professional journal articles, YouTube videos, relevant websites, Social Media feeds e.g., Twitter	**2.23**	**1.03**	**163**	**.822**	**.879**	**0.426**	**.588**	**.721**
I use my device(s) to challenge my existing ideas by considering other arguments from relevant websites, feeds etc.	**3.14**	**1.04**	**163**	**.828**	**.879**	**0.426**	**.417**	**.553**
I feel confident that I am equipped to use mobile devices to effectively facilitate my learning	**2.10**	**0.95**	**163**	**.828**	**.879**	**0.426**	**.860**	**.913**
Mobile learning helps me to make links to types of information and helps connect these together e.g., a resource (e.g., website, YouTube video, Twitter feed, Facebook link) may have a link or links to other learning resources, e.g., YouTube etc. that aid my understanding of a course concept.	2.36	0.89	**163**	**.831**	**.879**	**0.426**	**.521**	**.709**
I use my device(s) to supplement my existing learning.	2.36	0.95	**163**	**.826**	**.879**	**0.426**	**.598**	**.738**

Table 4.13. Summary of Factor (Construct) 1 Reliability and Validity.

Factor 2 Results

Consistency, Reliability Extraction and Factor Loading values Relating to factor 2	Mean	SD	N	Cronbach A	Composite Reliability	Average Variation	Extraction	Factor loading
I find it useful to use my device(s) to record/store notes from university	**2.93**	**1.16**	**163**	**.830**	**.683**	**0.268**	**.453**	**.498**
I use my device(s) to assess my performance and skills e.g., by video capturing and analysing my performance of skills.	2.74	**1.07**	**163**	**.844**	**.683**	**0.268**	**.696**	**.826**
I use my device(s) to create documents to assist reflection and organisation e.g., lecture/seminar notes, assignment plans, Gantt charts	3.59	1.79	163	**.860**	**.683**	**0.268**	**.491**	**.509**
I use my device to create audio visual resources e.g., video	2.64	**1.12**	**163**	**.834**	**.683**	**0.268**	**.722**	**.830**

Table 4.14. Summary of Factor (Construct) 2 Reliability and Validity.

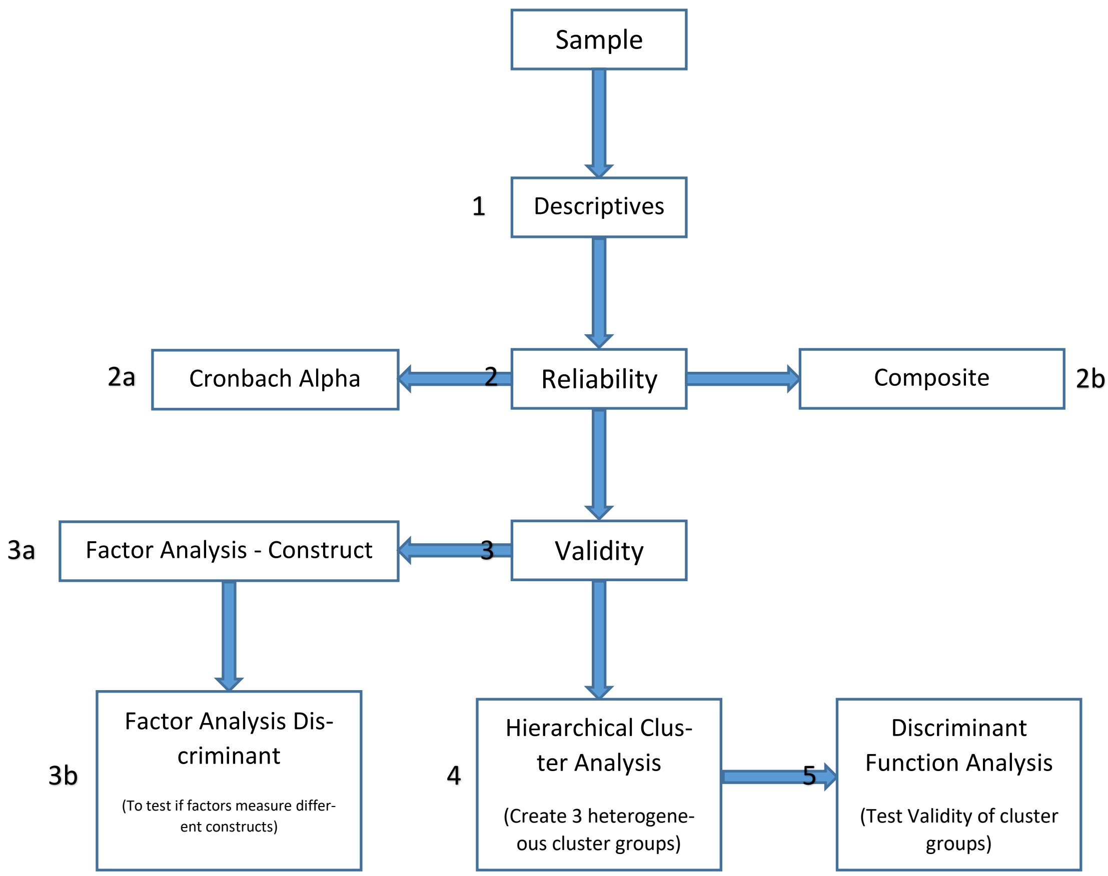
Factor 3 Results

Consistency, Reliability Extraction and Factor Loading values Relating to factor 3	Mean	SD	N	Cronbach A	Composite Reliability	Average Variation	Extraction	Factor loading
I would like to see sessions that encourage the use of mobile learning within taught sessions in university	**2.93**	**1.16**	**163**	**.830**	**.892**	**0.536**	**.453**	**.498**
I would like to see sessions that demonstrate the uses of mobile learning within taught sessions in university	2.74	**1.07**	**163**	**.844**	**.892**	**0.536**	**.696**	**.826**

Table 4.15. Summary of Factor (Construct) 3 Reliability and Validity.

The labels of 'Access to Knowledge' (Factor 1), 'Creation of Knowledge' (Factor 2) and 'Development' (Factor 3) were applied to the constructs following the Factor Analysis and demonstrated the survey questionnaire to have good validity around these three constructs. These were then used to examine the results within specific populations of the questionnaire respondents. It was therefore necessary to explore the sample for evidence of different behaviours and attitudes across these sub-sections. For this, a hierarchical cluster analysis was used and tested for validity of cluster groupings. Figure 4.2 below shows the further statistical steps in the data analysis.

Figure 4.2 (Below) Summary of Validity Procedures to Establish Validity of Questionnaire and Subsequent Use of Hierarchical Cluster Analysis with Discriminant Function Analysis.



Description of Cluster Analysis and Validity as a Sampling Procedure for Qualitative Study.

The previous section outlined the process for establishing questionnaire validity. This section will describe the process of cluster analysis to identify grouping similarities in participants who completed the survey questionnaire. It will describe the cluster analysis validation process and test for differences between the groups. The hierarchical cluster analysis will be used to identify different groups within the survey which will then be used to assist with the selection of a maximum variance sample for qualitative interviews. The chapter will then present the results of this analysis, followed by presentation of inferential statistics that show any significant differences between the group opinions.

Aims

- To identify suitable variables for use with Hierarchical Cluster Analysis (HCA).
- To test that identified variables are not correlated and provide independent data.
- To validate the use of HCA by establishing that groups produced are unrelated to each other (different).
- To test the prediction accuracy of the groups produced by HCA.
- To test for differences between the HCA groups using inferential statistics.
- To identify factors to assist the selection of a maximum variance sample for the qualitative study.

Hierarchical Cluster Analysis

A hierarchical cluster analysis is a popular multi-variate technique for segmentation of a sample. Its primary aim is to aggregate cases based on their characteristics and form groups with the greatest possible homogeneity within groups but also to produce groups with the greatest heterogeneity between groups (Carvalho, et al. 2015). The aim for this sample was to identify similar responses in the data and explore the possibility of selecting a variance sample for qualitative interviews based upon these. It is acknowledged that there is a degree of subjectivity when selecting variables for use with the cluster analysis. To address this subjectivity, the researcher used a powerful and efficient statistical technique known as discriminant analysis. This is used in conjunction with cluster analysis to validate the grouping methodology (Carvalho, et al. 2015). Dependent variables used for the hierarchical cluster analysis were selected as they were a continuous level of data and included demographics from the first section of the questionnaire. The variables selected were previous academic background, number of mobile devices owned, year of study, average time (in hours) per week spent accessing resources with mobile technology and perceived value of mlearning derived from the mlearning usefulness score. These variables were normally distributed; however, it is acknowledged that even with metric estimation, there remains a level of subjectivity.

The results presented below show the validation process of the statistical technique prior to then presenting the results of the cluster analysis groupings.

Validation with Discriminant Function Analysis.

Based on the results of the discriminant analysis, five variables were tested for validity of grouping from the hierarchical cluster analysis (academic background, year of study, mlearning usefulness, average hours per week spent accessing resources with mobile tech, number of devices). Wilks Lambda show a significant difference, in all predictor variables bar 'Year of Study'.

Test of Equality of Group Means	Wilks' Lambda	F	Df 1	Df 2	Sig
mlearning Usefulness	.412	109.284	2	153	.000
Academic Background	.304	174.778	2	153	.000
Number of Devices	.948	4.201	2	153	.017
Year of Study	.999	.055	2	153	.947
Frequency of Contact	.961	3.092	2	153	.048

Table 4.16. Wilks Lambda Statistic for Significance of Predictor Variables

Variation and Appropriateness of Predictor Variables

Pooled matrices also demonstrated that variables were not correlated strongly with each other hence represented a variation in predictor variables which is useful for within group homogeneity and between group heterogeneity.

Pooled Within-Group Matrices	Mlearning Usefulness	Academic Background	Number of Devices	Year of Study	Frequency
mlearning Usefulness	1.000	-.236	-.016	-.004	-.195
Academic Background	-.236	1.000	.187	.006	.129
Number of Devices	-.016	.187	1.000	-.041	-.037
Year of Study	-.004	.006	-.041	1.000	.282
Frequency of Contact	-.195	.129	-.037	.282	1.000

Table 4.17. Pooled Matrices Correlations Between Predictor Variables

Heterogeneity of Groups

Box’s M shows a significance of p<0.001 allowing rejection of the null hypothesis that the groups (clusters) are similar and demonstrating that the predictors variables have produced three different groups. This validates the use of the hierarchical cluster analysis for production of three heterogeneous groups.

Box's M Test Results	Standardised Canonical Discriminant Function Co-efficient
Box's M	86.704
F Approx.	2.734
DF 1	30
DF 2	33334.482
Sig	<0.001

Table 4.18 Box’s M Tests Allow Rejection of Null Hypothesis of Equal Population Covariance Matrices.

Strength of Predictor Variables in Groupings

The canonical discriminant function correlations show that academic background and mlearning usefulness score were the best predictors of cluster grouping, whilst number of devices, year of study and frequency of access were less important. The academic background showed a clear distinction in groupings with a much higher proportion of 'A' Level students with high mlearning scores in cluster two. Cluster one showed a higher proportion of previous degree and diploma students with high mlearning scores, whereas cluster three showed the most heterogenous distribution of students across 'A' Level, Diploma, and degree backgrounds with lower mlearning scores.

	Standardised Canonical Discriminant Function Co-efficient	Discriminant Function Variable Co-efficient
mlearning Usefulness	.615	.789*
Academic Background	.962	.400
Number of Devices	-.113	.059
Year of Study	.002	-.042
Frequency of Contact	-.051	-.005

*Largest absolute correlation between each variable and any discriminant function

Table 4.19. show that academic background and mlearning usefulness score were the best predictors of cluster grouping.

Cluster Orientation

The results of the hierarchical cluster analysis showed three distinctive clusters and after validation with the discriminant analysis, these were then tested further using Kruskal-Wallis Tests for significant differences. Dunn's Post Hoc tests with Bonferroni corrections were used to identify where group differences lay if the Kruskal-Wallis tests showed significance. The hierarchical cluster analysis produced three clusters comprising of the following. Broadly, the clusters may be classed as follows: -

Cluster 1: Respondents who have a high affinity with mobile learning as a learning tool.

Cluster 2: Respondents who a medium to high affinity with mobile learning as a learning tool.

Cluster 3: Respondents who have a low affinity with mobile learning as a learning tool.

Clusters Produced Following Hierarchical Cluster Analysis				
	Frequency	Percent	Cumulative Percent	Valid Percent
Cluster 1	54	33	33	35
Cluster 2	71	43	76	46
Cluster 3	31	19	95	19
Total	156	95	95	100
Missing	7	5	5	0
Total	163	100	100	100

Table 4.20. Frequency in Clusters Following Hierarchical Analysis.

Age Distribution of Groups

The age distribution for each cluster was as shown in Table 4.21. Cluster one demonstrates the fewest in the 18-20 (4%) age group category and the highest in the two other categories. Cluster two shows 72% of the group in the 18-20 age category, whereas only 9% in the 26-45 category. Cluster three shows the highest percentage to be in the 21-25 age category, with a smaller number in the 26-45 age category.

Age	Cluster 1	Cluster 2	Cluster 3	Total
18-20	2 (4%)	51 (72%)	12 (39%)	65
21-25	29 (53%)	14 (19%)	14 (45%)	57
26-45	23 (43%)	6 (9%)	5 (16%)	34
Total	54	71	31	156

Table 4.21. Age Demographics for Clusters.

The seven cases missing from the analysis were due to incomplete data responses in the survey questionnaire.

Prediction Accuracy of Groups

Classification Results. Pooled Group Membership * **	mLearning Usefulness	Cluster 1	Cluster 2	Cluster 3	Total
Original Count	Cluster 1	51	3	0	54
	Cluster 2	2	68	1	71
	Cluster 3	0	5	26	31
	Ungrouped Cases	6	0	0	6
Percentage	Cluster 1	94.4	5.6	.0	100.0
	Cluster 2	2.8	95.8	1.4	100.0
	Cluster 3	.0	16.1	83.9	100.0
	Ungrouped Cases	100.0	.0	.0	100.0
Cross-Validated Count	Cluster 1	50	4	0	54
	Cluster 2	2	68	1	71
	Cluster 3	2	5	24	31
Cross-Validated Percentage b	Cluster 1	92.6	7.4	.0	100.0
	Cluster 2	2.8	95.8	1.4	100.0
	Cluster 3	6.5	16.1	77.4	100.0

* 92.9% of original grouped cases correctly classified. b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case. ** 91.0% of cross-validated grouped cases correctly classified.

Table 4.22. Classification Results Demonstrate Prediction Accuracies of 92.6% (Cluster 1), 95.8% (Cluster 2) And 77.4% (Cluster 3).

Inferential Statistics from Cluster Groupings.

Once the groups (clusters) had been validated and analysis had been shown to accurately predict participants from the survey questionnaire were correctly placed into the groupings, a more detailed statistical testing procedure could be performed.

Research Hypotheses

> There will be a significant difference in the opinion between the groups for 'Access to Knowledge' statements.
> There will be a significant difference in the opinion between the groups for 'Development of Knowledge' statements.
> There will be a significant difference in the opinion between the groups for 'Creation of Knowledge' statements.

Hypothesis Testing.

Both descriptive and non-parametric inferential tests were performed for the three independent groups (descriptive stats only were included for the whole group) to explore for any differences between these clusters. Clusters were then tested against the 14 questionnaire items that were previously tested for internal consistency. All differences were statistically significant at the $p<0.05$ level.

Tables 4.23 and 4.24 show the opinion statement averages (both median and mean results are included) for all clusters plus overall group averages for comparison. Both average mean and median results demonstrate cluster three to be different to the other groups.

Mean and Standard Deviation (SD) Scores for Whole Group and Individual Clusters – Opinion Statements									
	N	Overall Mean	Overall SD	Cluster 1 Mean	Cluster 1 SD	Cluster 2 Mean	Cluster 2 SD	Cluster 3 Mean	Cluster 3 SD
Use Mobile Primary Source Learning	163	3.47	1.17	3.35	1.29	3.18	0.95	4.13	1.12
Useful to Record and Store Record Notes	163	2.93	1.16	2.93	1.21	2.65	1.02	3.65	1.14
Use to Access New Unfamiliar Ideas	163	2.23	.99	2.05	.86	2.08	0.89	2.94	1.15
Use to Understand Challenge Clarify New Concepts	163	2.56	1.09	2.46	1.06	2.28	0.91	3.29	1.13
Use to Improve Current Knowledge Access Resources E.g., YouTube	163	2.23	1.03	2.17	.99	1.93	0.76	2.94	1.21
Use to Create Audio Visual Resources E.g., Video	163	2.64	1.12	2.57	1.16	2.59	1.05	2.97	1.22
Use to Create Documents Assist Reflection Organisation E.g., Gantt	163	3.47	1.06	3.48	1.06	3.25	1.08	3.87	0.92
Use to Challenge Existing Ideas Considering Other Arguments	163	3.14	1.04	2.85	1.09	3.03	0.94	3.71	0.94
Use to Assess Performance and Skills	163	2.74	1.07	2.69	1.18	2.80	0.92	2.87	1.20
Use to Convert Unproductive Time into Productive Time	163	2.74	1.11	2.46	1.08	2.65	0.94	3.16	1.21
Use to Supplement Existing Learning	163	2.36	.94	2.09	.78	2.21	0.81	3.10	1.08
Helps Link to Other Types of Information That Aid Understanding	163	2.36	.89	2.17	.84	2.34	0.77	2.55	1.06
Feel Confident Equipped to Use Device to Facilitate Learning	163	2.10	.95	2.07	1.01	1.94	0.75	2.52	1.03
Would Like to See Sessions Demonstrate mlearning	163	2.69	1.13	2.50	1.00	2.63	1.14	3.23	1.18
Would Like to See Sessions Encourage mlearning	163	2.57	1.04	2.37	.83	2.42	1.00	3.29	1.13
Valid N (listwise, missing = 7)	163		54		71			31	

Table 4.23. Mean and Standard Deviation (SD) Scores for Whole Group and Individual Clusters – Opinion Statements

Below Overall Mean
Above Overall Mean

Median and Interquartile Range (IQ) Scores for Whole Group and Individual Clusters – Opinion Statements									
	N	Overall Median	Overall IQ Range	Cluster 1 Median	Cluster 1 IQ Range	Cluster 2 Median	Cluster 2 IQ Range	Cluster 3 Median	Cluster 3 IQ Range
Use Mobile Primary Source Learning	163	4	3-4	3.5	2-4	3	3-4	4	4-5
Useful to Store Record Notes	163	3	2-4	3	2-4	2	2-4	4	3-4
Use to Access New Unfamiliar Knowledge	163	2	2-3	2	2-2	2	1-3	3	2-4
Use to Understand Challenge Clarify New Concepts	163	2	2-3	2	2-3	2	2-3	3	2-4
Use to Improve Current Knowledge Access Resources E.g., YouTube	163	2	2-3	2	2-2	2	1-2	2	2-4
Use to Create Audio Visual Resources E.g., Video	163	2	2-4	2	2-4	2	2-4	3	2-4
Use to Create Documents Assist Reflection Organisation E.g., Gantt	163	4	3-4	4	3-4	4	2-4	4	4-4
Use to Challenge Existing Ideas Considering Other Arguments	163	3	2-4	3	2-4	3	2-4	4	3-4
Use to Assess Performance and Skills	163	2	2-4	2	2-4	3	2-4	3	2-4
Use to Convert Unproductive Time into Productive Time	163	2	2-4	2	2-3.25	2	2-3	4	2-4
Use to Supplement Existing Learning	163	2	2-3	2	2-2	2	2-2	3	2-4
Helps Link to Other Types of Information That Aid Understanding	163	2	2-3	2	2-3	2	2-3	2	2-4
Feel Confident Equipped to Use Device to Facilitate Learning	163	2	1-2	2	1-2	2	1-2	2	2-3
Would Like to See Sessions Demonstrate mlearning	163	3	2-3	2	2-3	2	2-3	3	2-4
Would Like to See Sessions Encourage mlearning	163	2	2-3	2	2-3	2	2-3	4	2-4
Valid N (listwise, missing = 7)	163		54		71			31	

Table 4.24. Median and Interquartile Range (IQ) Scores for Whole Group and Individual Clusters – Opinion Statements

Below Overall Median / IQ Range
Above Overall Median / IQ Range

Kruskal-Wallis tests were shown to produce significant differences between the clusters, but the results were then separated by the type of statement / opinion was being sought. The opinion questions were themed according to the type of activity that the mobile technology was being used for. The type of question / opinion was divided into 5 themed areas that explored the participants' responses around the following themes. The rationale for these themes was based on similarity of question and involved key words in the questions e.g., 'challenge' was present in both grouped questions, either 'create' or 'store' was present in all three grouped questions.

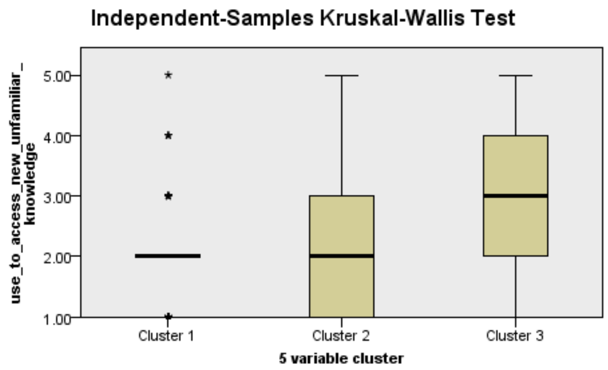
- Access Statements (Factor / Construct 1) - the respondents are using mobile technology to access material and research material and to challenge their understanding of concepts and ideas that is largely unfamiliar or where their understanding is less well developed.
- Development Statements (Factor / Construct 2) - the respondents are considering their competence, receptiveness, and ability to use of mobile technology as method to develop their knowledge.
- Creation Statements (Factor / Construct 3) - the respondents are using mobile technology in a creative manner to store knowledge and to assess their own clinical skills and how these may integrate with theory.

Responses to Access to Knowledge Themed Statements

Delphi Statements Relating to rating scale statement Responses to Access to Knowledge Themed Statements	Cluster 1 High Engagement	Cluster 2 High to Medium Engagement	Cluster 3 Low Engagement	SIG Kruskal Wallis	Post Hoc Dunn's Test	Hypothesis
I find it useful to use my device(s) to research new and unfamiliar ideas introduced at university.	**Agree**	**Agree**	**Neither Agree / Disagree**	**.000***	**.005 C1 .000 C2**	**Accept Exp. Hypothesis**
I use my mobile device as my primary source of learning on my course/programme.	**Neither Agree / Disagree**	**Neither Agree / Disagree**	**Disagree**	**.000***	**.002 C1 .000 C2**	**Accept Exp. Hypothesis**
I use my device(s) to challenge and clarify my existing ideas around concepts learned at University	**Agree**	**Agree**	**Neither Agree / Disagree**	**.000***	**.001 C1 .000 C2**	**Accept Exp. Hypothesis**
I use my device(s) to improve current knowledge by accessing learning resources e.g., professional journal articles, YouTube videos, relevant websites, Social Media feeds e.g., Twitter	**Agree**	**Agree**	**Neither Agree / Disagree**	**.000***	**.003 C1 .000 C2**	**Accept Exp. Hypothesis**
I use my device(s) to challenge my existing ideas by considering other arguments from relevant websites, feeds etc.	**Neither Agree /Disagree**	**Neither Agree /Disagree**	**Disagree**	**.001***	**.002 C1 .001 C2**	**Accept Exp. Hypothesis**
I feel confident that I am equipped to use mobile devices to effectively facilitate my learning	**Agree**	**Agree**	**Agree**	**.021***	**.022 C1 .007 C2**	**Accept Exp. Hypothesis**
Mobile learning helps me to make links to types of information and helps connect these together e.g., a resource (e.g., website, YouTube video, Twitter feed, Facebook link) may have a link or links to other learning resources, e.g., YouTube etc. that aid my understanding of a course concept.	**Agree**	**Agree**	**Agree**	**.285**	**NS**	**Accept Null Hypothesis**
I use my device(s) to supplement my existing learning.	**Agree**	**Agree**	**Neither Agree / Disagree**	**.000***	**.000 C1 .000 C2**	**Accept Exp. Hypothesis**
Across Factor/Construct	**Agree**	**Agree**	**Neither Agree / Disagree**			**Overall Accept Experimental Hypothesis**

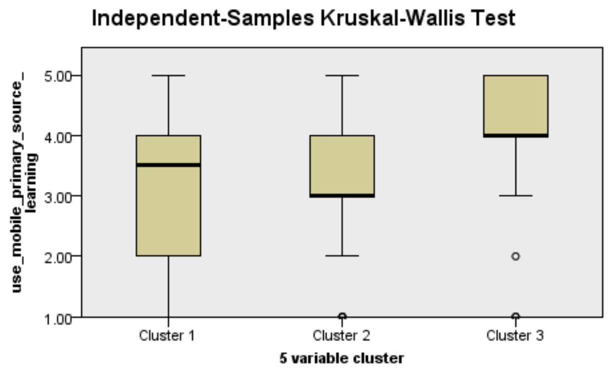
Table 4.25. Statements around Access Themed Questions

Shaded boxes show Cluster 3 to be significantly different to the other clusters in seven statements and across the construct.



Total N	156
Test Statistic	15.258
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

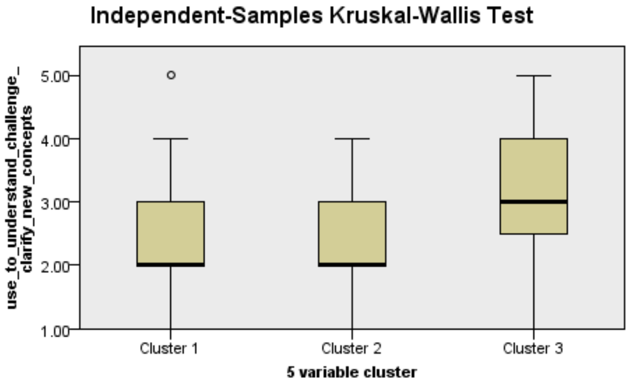


Total N	156
Test Statistic	18.647
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

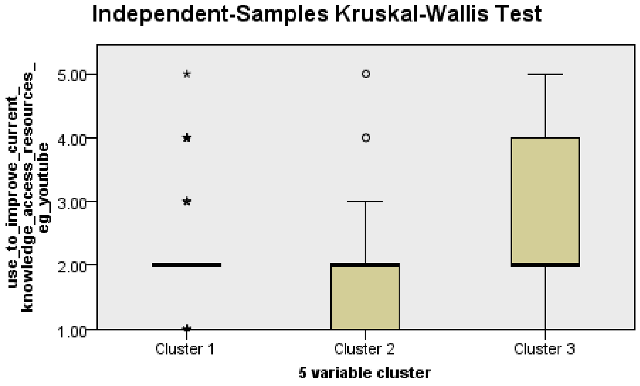
Graph 4.3 (Left Graph) "I find it useful to use my device(s) to research new and unfamiliar ideas introduced at University."

Graph 4.4 (Right Graph) "I use my mobile device as my primary source of learning on my course/programme."



Total N	156
Test Statistic	17.192
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

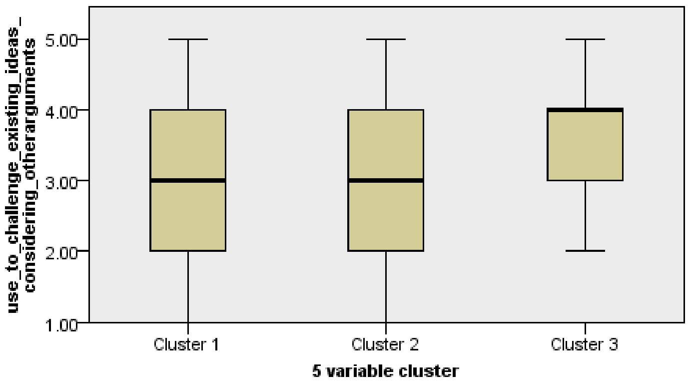


Total N	156
Test Statistic	16.596
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

Graph 4.5. (Left Graph) "I Use My Device(S) To Challenge and Clarify My Existing Ideas Around Concepts Learned at University".
Graph 4.6. (Right Graph) "I Use My Device(S) To Improve Current Knowledge by Accessing Learning Resources E.G. Professional Journal Articles, YouTube Videos, Relevant Web-sites, Social Media Feeds E.G. Twitter".

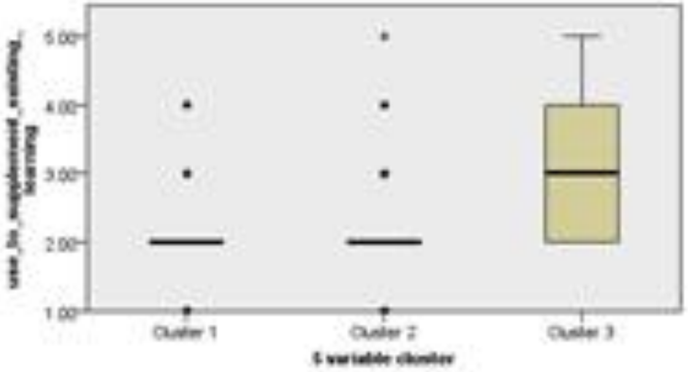
Independent-Samples Kruskal-Wallis Test



Total N	156
Test Statistic	13.392
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.001

1. The test statistic is adjusted for ties.

Independent-Samples Kruskal-Wallis Test



Total N	156
Test Statistic	21.380
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

Graph 4.7. (Left Graph) "I Use My Device(S) To Challenge My Existing Ideas by Considering Other Arguments from Relevant Websites, Feeds Etc."
Graph 4.8. (Right Graph) "I Use My Device(S) To Supplement My Existing Learning."

These questions explored responses aimed at using mobile technology to access material and research material that is largely unfamiliar or where their understanding is less well developed. A clear distinction was seen between cluster three and the other two clusters in these opinions. Cluster three demonstrated significant differences in their use of mobile devices for knowledge research, exploration, and access purposes (p=0.00, median scores = 3). Clusters one and two agreed with both statements in this theme and gave an indication that this strategy was commonly used (median = 2).

These questions explored the respondents' self-judged competence, receptiveness, and ability to use of mobile technology as method to develop their knowledge. Significant differences between clusters were demonstrated for each question within this theme. The inter quartile range for self-judged confidence does however point to cluster three having more respondents scoring in the 2-3 range, whereas clusters one and two both demonstrate interquartile ranges between 1-2 (strongly agree to agree). This important point explains in part why there is a significant difference between the clusters (p=0.021) and perhaps suggests an important link why confidence may be an important part of the relationship in the adoption of mlearning.

Whilst there is some variability in the confidence of respondents and desire to encourage or see demonstrations of mlearning, none of the clusters agreed that mlearning was a primary source of learning. Whilst clusters one and two gave neutral responses to this question (median score = 3.5 for cluster one, median score = 3 for cluster two), cluster three generally disagreed that they use mlearning as a primary source of learning. The interquartile range for cluster one shows a greater spread (scores 2-4) in comparison to cluster two (scores 3-4) and cluster three (scores 4-5), hence this may point to a greater number of respondents who agree with this statement. Cluster one also demonstrates a small number within the first quartile who strongly agree with this statement, suggesting a small subset of cluster one who do use mlearning as a primary form of learning.

When students were asked if they used a mobile device to challenge their understanding of concepts and ideas, a significant difference was seen in the respondents in cluster three. This cluster demonstrated a general disagreement (median =3) when using mobile technologies for this purpose. This is significantly different to clusters one and two ($p=0.00$) where both groups showed a general agreement in this area (median =2). This was limited to challenging and clarification purposes as although they showed a significant difference from cluster three ($p=0.01$) when asked about considering alternative theoretical arguments when using mobile technology, the general tendency was neutral (median score = 3) in comparison to cluster three (median score = 4).

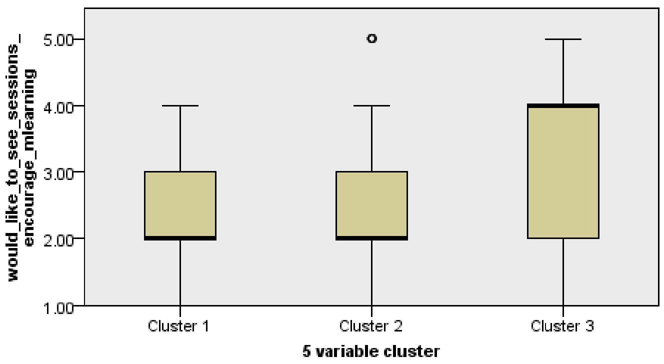
Responses to Development Construct.

DELPHI STATEMENTS RELATING TO RATING SCALE STATEMENT Responses to Development Themed Statements	CLUSTER 1 HIGH ENGAGEMENT	CLUSTER 2 HIGH TO MEDIUM ENGAGEMENT	CLUSTER 3 LOW ENGAGEMENT	SIG KRUSKAL WALLIS	POST HOC DUNN'S TEST	HYPOTHESIS
I would like to see sessions that encourage the use of mobile learning within taught sessions in University	**Agree**	**Agree**	**Disagree**	**.000***	**.000 C1 .007 C2**	**Accept Exp. Hypothesis**
I would like to see sessions that demonstrate the uses of mobile learning within taught sessions in University	**Agree**	**Agree**	**Neither Agree / Disagree**	**.017***	**.006 C1 .017 C2**	**Accept Exp. Hypothesis**
Across Factor/Construct	**Agree**	**Agree**	**Neither Agree / Disagree**			**Accept Exp. Hypothesis**

Table 4.26. Statements Around Development Questions.

Shaded boxes show Cluster 3 to be significantly different to the other clusters in both statements and across the construct

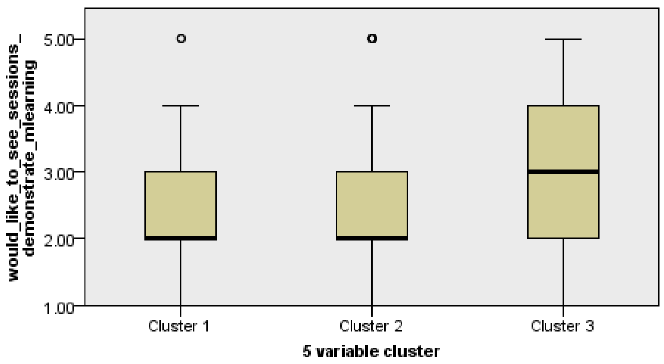
Independent-Samples Kruskal-Wallis Test



Total N	156
Test Statistic	15.331
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

Independent-Samples Kruskal-Wallis Test



Total N	156
Test Statistic	8.118
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.017

1. The test statistic is adjusted for ties.

Graph 4.9 (Left Graph) "I Would Like to See Sessions That Encourage the Use of Mobile Learning Within Taught Sessions in University."
Graph 4.10 (Right Graph) "I Would Like to See Sessions That Demonstrate the Uses of Mobile Learning Within Taught Sessions in University."

While all clusters felt confident that they were equipped to use a mobile device for mlearning purposes (median score = 2 for all clusters), cluster three differed significantly from the other clusters when asked if they would like to see teaching sessions that demonstrate or encourage the use of mlearning. Cluster three disagreed that they would like to see sessions of this nature encouraged (median score = 4) in comparison to clusters one and two (median score = 2).

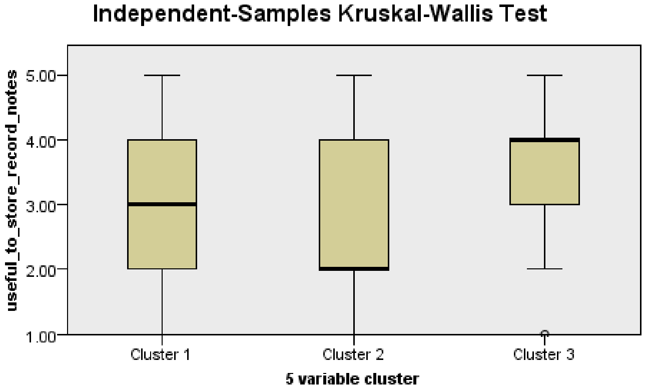
Responses to Create Knowledge Statements

DELPHI STATEMENTS RELATING TO RATING SCALE STATEMENT Responses to Create Knowledge Themed Statements	CLUSTER 1	CLUSTER 2	CLUSTER 3	SIG	POST HOC	HYPOTHESIS
	HIGH AFFINITY	MEDIUM TO HIGH AFFINITY	LOW AFFINITY	KRUSKAL WALLIS	DUNN'S TEST	
I find it useful to use my device(s) to record/store notes from university	**Neither Agree / Disagree**	**Agree**	**Disagree**	**.000***	**.007 C1 .000 C2**	**Accept Exp. Hypothesis**
I use my device(s) to assess my performance and skills e.g., by video capturing and analysing my performance of skills.	**Agree**	**Neither Agree / Disagree**	**Neither Agree / Disagree**	**.594**	**NS**	**Accept Null Hypothesis**
I use my device(s) to create documents to assist reflection and organisation e.g., lecture/seminar notes, assignment plans, Gantt charts	**Disagree**	**Disagree**	**Disagree**	**.020***	**NS C1 .005 C2**	**Partial Accept Exp. Hypothesis**
I use my device to create audio visual resources e.g., video	**Agree**	**Agree**	**Neither Agree / Disagree**	**.255**	**NS**	**Accept Null Hypothesis**
Across Factor/Construct	**Agree: Neither Agree / Disagree ***	**Agree: Neither Agree / Disagree ***	**Neither Agree / Disagree: Disagree ***			**Reject Exp Hypothesis**

Table 4.27. Statements Around Link and Access Questions.

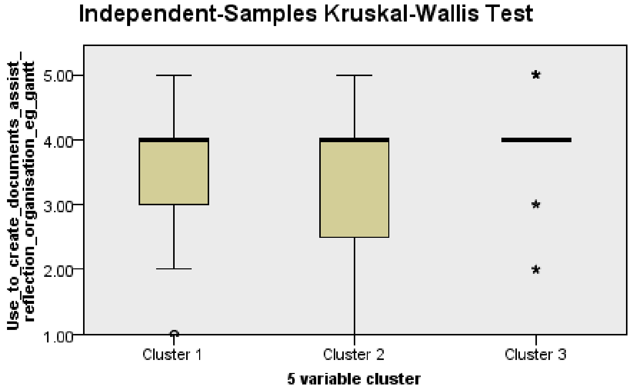
Shaded boxes show Cluster 3 to be significantly different to cluster two in two statements but across the construct there are no clear differences. The use of video creatively was embraced by all clusters, and this can be seen due to the non-significant differences in statements 2 and 4 from this construct.

*Indicates that median score is between 2 points in scale, therefore, statements are represented as joint statements. Red text indicates the tendency either side of the midpoint score.



Total N	156
Test Statistic	15.259
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.000

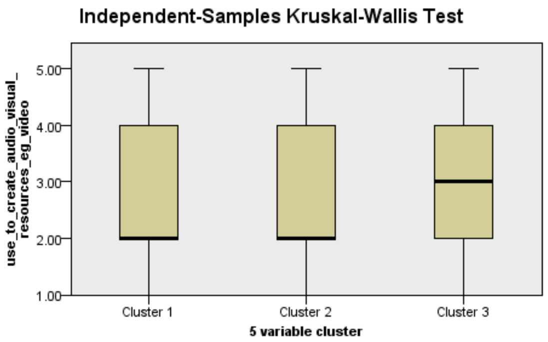
1. The test statistic is adjusted for ties.



Total N	156
Test Statistic	7.779
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.020

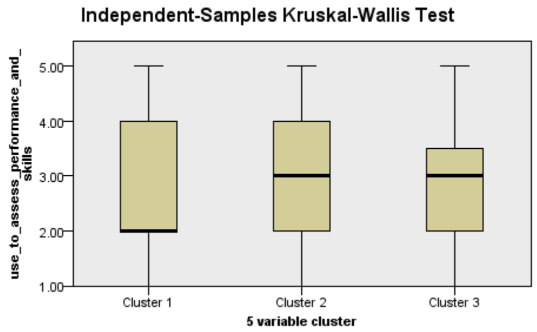
1. The test statistic is adjusted for ties.

Graph 4.9 (Left Graph) "I Find It Useful to Use My Device(S) To Record/Store Notes from University".
Graph 4.10 (Right Graph) "I Use My Device(S) To Assess My Performance and Skills E.G. By Video Capturing And Analysing My Performance of Skills."



Total N	156
Test Statistic	2.733
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.255

1. The test statistic is adjusted for ties.
2. Multiple comparisons are not performed because the overall test does not show significant differences across samples.



Total N	156
Test Statistic	1.041
Degrees of Freedom	2
Asymptotic Sig. (2-sided test)	.594

1. The test statistic is adjusted for ties.
2. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

Graph 4.11 (Left Graph) “I Use My Device(S) To Create Documents to Assist Reflection and Organisation E.G. Lecture/Seminar Notes, Assignment Plans, Gantt Charts.”
Graph 4.12 (Right Graph) “I Use My Device to Create Audio Visual Resources E.G. Video.”

Distribution Boxplots showing Minimum, Maximum, Median and Quartiles for Creation Statements

These questions explored if the respondents' used mobile technology in a creative manner to create and store knowledge rather than an access method to consume knowledge. Significant differences were shown in one of the themes in this area. All clusters disagreed that they used mobile technologies to create and store reflective and organisational documents, or notes from formal learning situations such as lectures, seminars etc. Although all clusters disagreed with this statement, significance was seen, most likely due to the spread of results in clusters one and two. Interquartile ranges were seen between 3 and 4 for cluster one, and between 2.5 and 4 for cluster two. Cluster three showed a median score and range of 4 only but did demonstrate 3 outliers. The storage of notes (presumably from non-formal learning situations) showed a significant difference (p=0.00). Clusters one and two both agreed with this statement, whereas cluster three disagreed with this statement. Cluster two (median score = 2, IQR 2-4) and cluster one (median score = 3 IQR 2-4). Cluster one and two both agreed that they used their mobile devices to create audio-visual resources such as video for learning, whereas cluster three were neutral in their responses, hence there were no significant differences between the median response scores in this area (p=0.255).

These questions explored the respondents' use of mobile technology to assess their own clinical skills and how these may integrate with theory. The responses to questions showed no significant difference in the opinions of the respondents (p=0.594). This theme demonstrates the greatest area of agreement between the 3 clusters and perhaps shows that the use of video capture for assessment and analysis reasons is the most widely used practice within the sample of Physiotherapy students. The general agreement that students use their mobile devices to link and connect types of information together (median = 2), perhaps hints that personal video capture may be used for comparison of clinical based skills reasons against previously posted examples that are publicly available. In contrast, it is possible that publicly available examples may be consulted prior to video capture of the respondents' clinical skills. The non-significant trend between cluster two (median score = 3) and the other clusters (median score = 2) demonstrates a partial engagement in the practice of video capture.

Summary of Findings

CLUSTER 1	CLUSTER 2	CLUSTER 3
HIGH AFFINITY	MEDIUM TO HIGH AFFINITY	LOW AFFINITY
Proportionately lower number of 18-20s (Mean age 26.8)	Proportionately higher number of 18-20s (mean age 20.7)	Proportionately lower number of 26-45 (Mean age 22.4)
Some agreement that mlearning challenges existing knowledge of respondent.	Some agreement that mlearning challenges existing knowledge of respondent.	Some disagreement that mlearning challenges existing knowledge of respondent.
High agreement that mlearning fosters access to existing knowledge and further research into existing knowledge.	High agreement that mlearning fosters access to existing knowledge and further research into existing knowledge.	Neutral opinion that mlearning fosters access to existing knowledge and further research into existing knowledge.
High agreement that mlearning facilitates ability to link knowledge possibly through methods of video capture for assessment of skills.	High agreement that mlearning facilitates ability to link knowledge possibly through methods of video capture for assessment of skills.	High agreement that mlearning facilitates ability to link knowledge possibly through methods of video capture for assessment of skills.
High self-perceived level of competency and receptiveness to further development.	High self-perceived level of competency and some receptiveness to further development.	Lower self-perceived level of competency and low receptiveness to further development.
High agreement that mlearning is useful for creative and storage of self-generated learning resources.	High agreement that mlearning is useful for creative and storage of self-generated learning resources.	High disagreement that mlearning is useful for creative and storage of self-generated learning resources.
Respondents use device for longer mean time per week (5.7 hours).	Respondents use device for longer mean time per week (5.3 hours).	Respondents use device for shorter mean time device per week (2.1 hours).
Possess more devices (median = 2)	Possess more devices (median = 2)	Possess fewer devices (median = 1)
More than half possess tablet (65%)	More than half possess tablet (56%)	Less than half possess tablet (32%)
Dominant Visual Learning Style Preference (70%)	Dominant Visual Learning Style Preference (58%)	Highest Kinaesthetic Learning Style Preference (65%)
Tendency Toward Kinaesthetic Learning Style Preference (56%)	Fewer Tendencies Toward Kinaesthetic Learning Style (46%)	Dominant Visual Learning Style Preference (65%)

Table 4.28. Summary of Statement and Study Preference Findings by Cluster.

Qualitative Results and Findings.

Introduction.

This section presents the results of 23 semi-structured interviews that were undertaken with BSc (Hons) Physiotherapy students. Results of the survey questionnaire have been presented previously. Whilst the survey questionnaire was distributed to both BSc (Hons) and MSc Physiotherapy (Pre-Registration) Students, only BSc (Hons) students volunteered to be interviewed. The narrative below outlines the general findings from the interviews and provides a preface for the developing themes and common patterns seen across all interview participants and common patterns seen across the groups that were identified from the survey questionnaire. It highlights again, how participants were recruited and the initial steps of the familiarisation process. This will be explored in further detail later in the chapter.

Overview of Initial Findings from Semi-Structured Interviews.

All students had previously completed the author developed mlearning Questionnaire and were selected to provide a maximum variance sample. Framework analysis was used to construct the findings using the five stages of familiarisation, thematic framework, indexing, charting and mapping and abstract interpretation. A more detailed representation of this process is included in the text to show details of how the process evolved. Remaining charts are shown in the appendices.

The familiarisation process commenced both during and following the interviews. Each interview was transcribed verbatim by the writer and then reread against the recorded audio for accuracy. Following the transcription, interviews were then reread separately, and initially, early themes were noted. The interviews were read according to their composite score from the survey questionnaire, and it was evident that there were similarities between high and low scoring participants and the related groupings that the hierarchical cluster analysis had generated. There were some contrasts in the uses and level of proficiency, however, definite similarities were observed.

Certain learning strategies were common amongst all participants and the use of mobile technology was not limited to particular environments. The use of particular digital formats was described and ranged from visual, audio and participatory methods. These often varied from self-generated resources such as video and voice recordings, to accessing popular consumer-based platforms such as YouTube, or social media links through platforms such as Twitter and Facebook. Participants talked about their experiences from a positive perspective and how mobile technology can act as a very useful support tool, however it was also observed that mobile technology could act as a distraction and hence certain environments were favoured over others e.g., the University library was often cited as a quiet environment where distractions were reduced. It also emerged that proficiency with technology often influenced the engagement with it for educational uses. Technologically proficient and literate participants often described different actions when their experiences were compared alongside less proficient participants. This was described in such digital environments as Twitter where it is possible to engage with users on a global level. It emerged early in the familiarisation process that proficiency with technology was possibly linked to online confidence and the desire to interact at a more macro-environmental level. Experiences of these interactions ranged from posing questions to international academics or to sharing of resources with a wide range of peers both locally and nationally.

What was observed in the data was that mobile technology was used in varying degrees amongst participants. Further analysis was required to discover the detailed reasons why.

The detailed findings will now be presented, together with diagrammatic representations of how the findings were themed.

Findings.

The following pages will present the framework findings from the four emergent themes and demonstrate the development of these themes using the Framework approach to data analysis

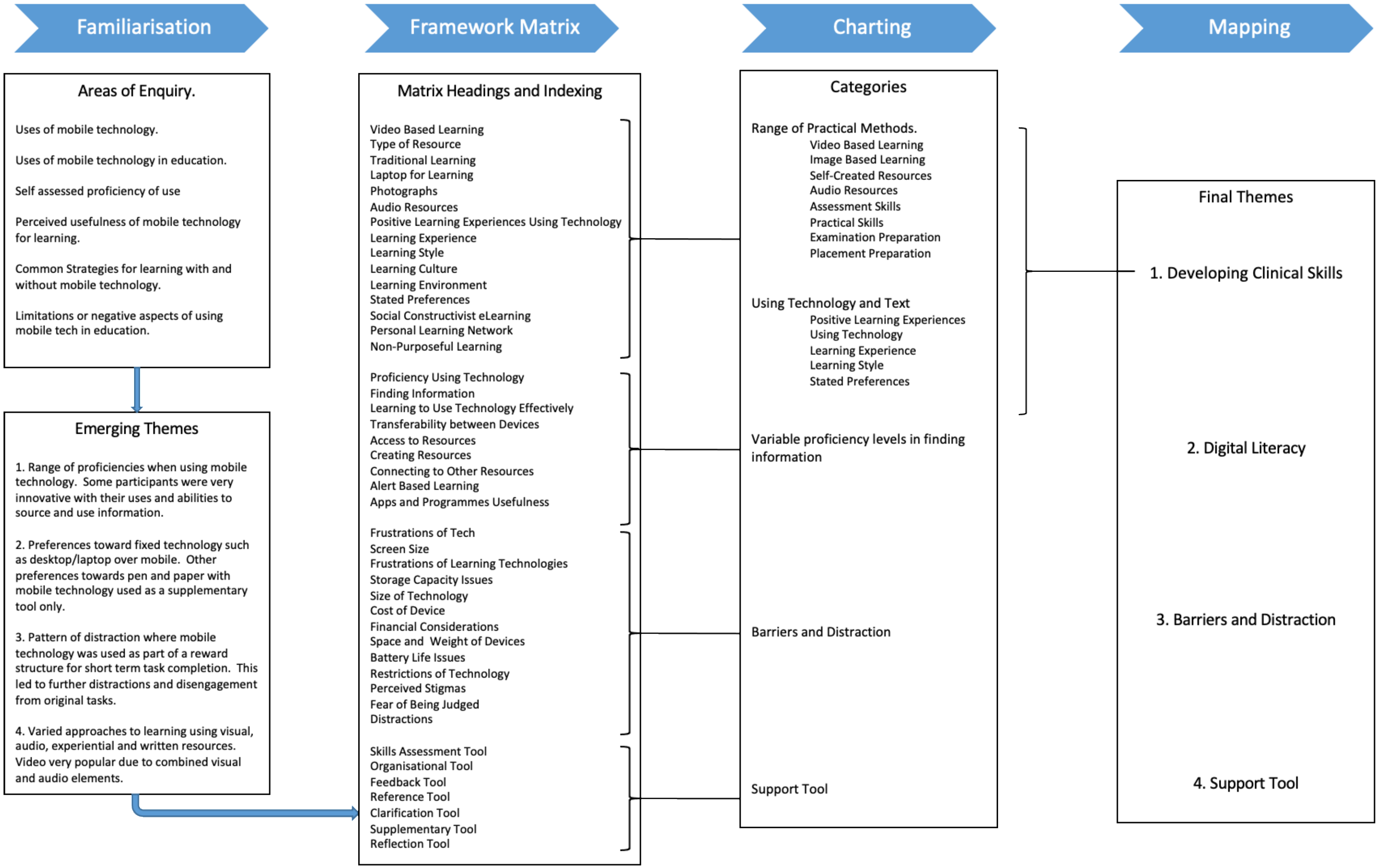


Table 4.30. Development of Clinical Skills Theme.

Detailed Analysis of Findings

Theme 1. Development of Clinical Skills

The mapping process identified the wide range of learning methods, from traditional, non-digital to digitised multimedia resources described by participants and how these could be used in isolation, but also in combination with each other. The use of combined methods offered a 'duality' or composite approach to learning that participants described as helpful when positive results were perceived and were often linked to previous experiences and cultures e.g., school policies around the use of mobile technology etc. Thus, the wide range of strategies described and experienced by participants could be considered as flexible with the capacity of increasing their own personal learning boundaries. These boundaries embraced mobile and digital strategies in a number of ways.

Development of Clinical Skills

The use of video for learning was by far, the most frequently cited use for learning mediated by mobile devices, regardless of digital competency, previous experiences of learning or barriers experienced with technology. The positive use of video for learning was cited mostly, due to its ease of use and the ability of the videos to clarify concepts that were less well understood when text-based resources were initially used. Participants valued the use of video for learning both clinical skills and also theoretical concepts as it could supplement learning or be used as a primary method where other strategies such as learning via text-based resources had been unsuccessful.

The use of video was used commonly in two ways. Firstly, video that was self-created or created within a peer group and then shared and secondly, using video that was created and shared by others e.g., academic staff, or through social media sites such as Facebook, YouTube etc. These were found to be intricately linked as many participants initially used commercial sites such as YouTube to explore early and initial theoretical concepts, or to explore practical aspects of a subject such as a treatment techniques or assessment procedures to better understand aspects of skills such as body position, hand position and the chronological order of how to perform a skill. Participants cite YouTube as an initial source of information that, following keynote lectures was used to expand and understand the key points of a theory or practical skill in an easy and useful way. Access to video was through a number of different methods, however Smartphones were used primarily due to their portability and ubiquitous capability and access. Participants nearly always had their Smartphones with them; hence it was the most convenient way to access video. Participant 16 cites the use of a Smartphone being much more convenient than via laptop due to the added steps of start-up, logging on etc.

> *I wouldn't go out of my way to watch my laptop and watch a video there if I could watch it quickly on my phone. (Participant 16, Male, BSc. Level 5).*

Participants primarily used video as a vehicle to learn and develop clinical skills, which had been learned in class time and would be possible skill components of a modular assessment e.g., in a practical examination. Often YouTube was a starting point, as it gave opportunity for participants to peruse a number of self-selected videos using their own search criteria. These could be used in isolation or together with videos made available by staff, on the eLP (Blackboard). Participants showed an awareness that some content on platforms such as YouTube is not always peer reviewed and this influenced their choice of which videos they chose to engage with. These included criteria such as the 'metrics of the video and if they were favourable e.g., Participant 2 cites the number of views on YouTube, participant 5 states if their credentials indicated that the content was questioned if it was not up-loaded/produced by a registered therapist from the country of origin.

> *Even though I really do like mobile learning, I kind of am a little bit of a stickler if I'm honest when it comes to social media. Because I think it's very very easy for people to put [upload] quite poor quality or even biased methods. (Participant 1 Male BSc Level 6).*

> *YouTube would have a good array of videos to do with certain techniques, probably the most techniques but then again how would I analyse the resource or whoever is doing it? Are they actually a qualified physio? (Participant 5 Male, BSc, Level 6).*

> *Well, I wouldn't just look at one video, I would look at a few. The biggest thing I would look at there is the view is the number of views that the video has that's how you know if it's a better video or a more entertaining video if they have more views. (Participant 5 Male, BSc, Level 6).*

Multiple videos could be used to gain an overall understanding of a technique or assessment procedure as this gave the ability to compare various approaches to a technique. This seemed to be a strategy used at an early stage of the learning process where a 'general consensus' was being formed about a technique or skill or helped to consolidate existing knowledge and understanding.

> *So, when I am studying, I look at video on YouTube first. Well, I actually look up about four or five videos and get the general consensus about it and generally write a script from the video. (Participant 11 Female, BSc, Level 6).*

> *I used YouTube videos also on my phone. You can find quite a lot on YouTube and it does re-inforce my understanding of things. (Participant 18, Female, BSc, Level 6).*

The video helped to supplement clinical skill acquisition that had been demonstrated in class time, as it provided a reminder of some of the learning had been lost due to lack of recall about the technique, hence these types of videos help re-enforce recollection of the techniques. This approach was quoted more commonly when a clinical skill had been recently introduced, or if the content was more intensive e.g., year 1 anatomy. A benefit of this video-based approach was that participants did not need to quickly make drawings of hand holds or quickly write down the technique in text format.

> *At the very beginning. I found it [video] most helpful. So, for example if you were just doing something from a practical element and you're trying to learn it I look at the video. (Participant 14, Female, BSc, Level 5).*
>
> *For our exam that we're currently studying for, we took a few videos of PNF stretches, which sometimes… because some particular patterns like it D1 or your D2 patterns are difficult to get your head around. So, from looking at them on the video, it easy to see exactly how it's done (Participant 1, Male, BSc, Level 6)*

Whilst University staff made skills videos available for students to view, many also chose to capture their own 'versions' of the staff demonstrations (after seeking lecturer consent) during classes. These were often shared with other students in the cohort and had the added value in that they served as a 'catch-up' service if students had not been present for a scheduled session. This could have been for a variety of reasons but was cited to be an enjoyable way of learning due to the visual nature of delivery. It also served as a medium to re-enforce previous learning in preparation for future session and allowed many participants to 'pace' their learning as it provided the ability to pause and rewind material in a manner that a traditionally taught session could not. This allowed participants to pace their learning to suit their understanding as they were able to break down the learning into smaller more manageable sections.

> *Being able to record and review that at several points before the next lecture helps refresh what we did in the previous lecture before the next one comes up. (Participant 3, Male, BSc, Level 5).*
>
> *I obviously download things off the ELP [staff videos] and keep them on my phone so I can refer to them. So, I do use like videos and things quite a bit. (Participant 7, Female, BSc, Level 6).*

As participants gained confidence in observing a skill, they then practiced and, as they gained competence with handholds or marking anatomical structures, they progressed to comparing their competency whilst watching a video either simultaneously or intermittently alongside their own practice. This approach initially involved watching a video from YouTube or watching a staff video and then comparing their own technique against this. Further progression involved capturing their own techniques.

> *When we were doing it first, we would definitely be using it [video capture]. We were sometimes figuring out what was done and just beginning to try and get it. (Participant 13, Male, BSc, Level 5).*

> *I'll look at the video again because sometimes when you are doing a technique you think you're doing it right but your hands are wrong. So, if it's a very specific technique that's why actually having the video…you can refer back to it and you can zoom in and zoom out and see things on the video, where the actual lecturers' hands are, their position and stuff. So, it gives you a good view of where to position your hands. (Participant 14, Female, BSc, Level 5).*

This was useful for correction of their own technique and self-reflection/peer discussion upon these techniques. Without the ability to capture and critically review their own techniques, participants (and students generally) are faced with far fewer opportunities to receive feedback upon competency from academic staff or be able to view their own strengths and weaknesses.

The use of a commercial platform such as YouTube had its biggest influence in the initial stages of learning a new clinical skill, followed by the use of staff-based videos to validate the technique, but as the participant's skill developed, they became less reliant upon these types of videos and began to capture their own techniques to review. These were viewed as hugely influential for their preparation for both University assessments which involved practical skills demonstration and for clinical placement preparation. These were cited most frequently with Level 5 (Year 2) skills, owing to the increased number of modular assessments that involved demonstration of clinical skills acquisition. They were also cited to be useful for foundation Level 4 knowledge in core areas such as cardiorespiratory, neurology and musculoskeletal modules, but often in a slightly different context e.g., surface palpation.

> *I think we're doing more videos when we were learning it than when we got a bit better at it because I felt like when we were practising, we were a bit better at it and that it was cementing it a bit more than looking at [YouTube] videos (Participant 13, Male, BSc, Level 5).*

The use of commercial video sites such as those cited by participants was popular due to the ease of access through an app on the Smartphones or tablets of all participants in the study. YouTube is also available via direct internet access, either via Smartphones, tablets or laptops, hence is very easy to access and was viewed as extremely useful for the acquisition of knowledge and skills. Video allowed participants to benefit from the commentary, the visual aspect of the video and, in cases where video was available from academic staff, notes pages. One participant did also state that the comments section in YouTube was useful to give wider perspectives or opinions regarding the video of choice and did help to clarify their understanding of a technique. This strategy was used successfully by this participant repeatedly and gave an additional option to assist in their learning.

> *Sometimes the comments that people say give you thoughts and give you ideas about the video and particularly if I don't understand the video. Then I'd look at the comments and I think, "oh yes now I understand". (Participant 14, Female, BSc, Level 5)*

What is evident from the data, is a pattern toward clarity and certainty. This was observed in different ways, as, on some occasions, clarity was described in relation to acquiring and performing a skill. Where video helped facilitate this skill development was where it demonstrated clarity in how to perform a technique. Learning clinical skills mediated through video capture was useful in this respect as it allowed time to study and perfect particular skills that had been taught during practical skills sessions. It was described as being a precise approach where, in many cases the video could be studied in detail to assess the positioning and posture of the body and hands, transfer of body weight, stance to gain a better understanding. Examples of this included delivering particular treatment techniques or performing specific aspects of physical examination such as specialised tests. Participants would cite experiences where they would then capture many examples of their own clinical skills and then review each video to consider how to improve their skills further or how these could help prepare participants for modular assessment.

> *I video them {own clinical skills] and then I have the video. Then I forget about it for ages and just before the exam I think oh yes, I have got a video and it's really helpful. (Participant 9, Female, BSc, Level 5).*

Often the participants describe watching videos via other social media e.g., Facebook, however more emphasis was placed on videos that were available from staff performing the techniques as this gave clarity [in the participants view] about the required standard. It served in their opinion to validate the technique and demonstrates a form of epistemic authority, where the staff videos demonstrating the technique were viewed as 'gold standard'. This was important when this related to the modular assessment of a technique, as participants valued certainty in how a technique was performed and thus would achieve a better result if they mirrored what was felt to be the correct execution of a technique.

> *I do prefer the videos on the University Blackboard than going to YouTube just because I know that that's what we want to be doing rather than anything that could be on the Internet. It is not as reliable, I think. (Participant 10, Female, BSc, Level 5).*

The enjoyable nature of learning skills through video stem from the experiences of not having to re-learn a topic or the flexibility of learning environment that it offered. Participants give examples of using either Smartphones, tablets and laptops whilst travelling, relaxing and practicing in practical contexts. Participant 9, from cluster one, used their Smartphone to access video and then, due to the small screen size of the Smartphone, projected this image to a TV to watch content in a more relaxed and convenient manner, largely due to the increased screen size offered.

> *I could put a video [from a Smartphone] on play, that you can cast to your telly [TV] and then sit down and have some food and watch that and if there's something quite engaging, I will learn a bit. (Participant 9, Female, BSc, Level 5).*

> *It was three quarters of the way through first year that I realised that people were learning from YouTube videos. I thought it had never even occurred to me to do that and then my friends emailed me one of Professor Fink's videos and it was brilliant. I learned half of my neuro through him with a glass of wine putting him on the telly. (Participant 9, Female, BSc, Level 5).*

Participant 7 however, valued the flexibility offered by having their own skills captured and then having the ability to access the footage in a number of differing environments. This was important for both skill acquisition and also for placement preparation as the organisation of video files into different folders allowed for easy retrieval when in differing contexts.

> *I have things saying, 'year 2', so it could be things such as, things to do with placements and then all the videos I've got on there, so I can look at them on my phone when I'm out and about as well (Participant 7, Female, BSc, Level 6).*

Placement preparation was cited as another example of the usefulness of using video capture to improve clinical skills in preparation for these periods of practice. Whilst initial reticence was a feature and participants cited a dislike for hearing their own voices or seeing themselves performing a skill, they came to realise the significance and value.

Whilst notes were used as a tool for placement preparation, the use of previously captured footage was a notable positive. These also served as snapshots for their skills at a particular point in time and could be used to observe and reflect on improvements in performance over certain time frames. This was useful for participants to look at their skill execution from an early point in the continuum and compare with later videos when skills were better developed.

> *I think the [self] video is a hugely important thing and is really important resource tool for going on placement. (Participant 5, Male, BSc, Level 6).*
>
> *I found it one of the most painful things to do and then at the end it was very useful process and now I haven't reviewed them but knowing I have got an MSK placement in the summer, and I actually need to revise where my muscles and stuff are, so I'd probably go back and watch some of those videos that I took to see what we did. (Participant 9, Female, BSc, Level 5).*

The value of resources however had certain limitations around the authenticity of the created scenario that was being rehearsed. Clinical skill acquisition when mediated through mobile was described as a helpful experience when learning was progressive and authentic. Experiences where authentic learning was not perceived were described as emotionally challenging. Such instances occurred during activities such as role play involving video capture when scenarios were acted out as particular pathologies, however the model was an asymptomatic peer.

> *you've got to build a portfolio ready for working life and record yourself talking to yourself and it is difficult because a lot of what we do, you have to role play it and for a lot of people it feels so unnatural that you haven't got an actual patient in front of you. So, you feel really silly, like standing and I am saying "I am just going to have a listen to your chest" or "yes I can hear breath sounds" (Participant 15, Female, BSc, Level 6).*

Whilst capturing of skills through video was generally a useful experience, there was initially an uncomfortable perception about it. This experience of Participant 9 (below) was more noticeable with the more 'mature' participants in the sample.

> *When you asked us to video ourselves doing different techniques, I hated the idea of it the first few times. I found it one of the most painful things to do and then at the end it was a very useful process. (Participant 9, Female, BSc, Level 5).*

Experiences such as these above represent a common finding amongst participants who initially experience an emotional reluctance to engage with technology for learning but then find unexpectedly useful aspects due to the interactivity of the tasks involved.

The generation of learners who were more familiar with technology and a 'video culture', possibly as a result of the wider exposure to social media-based video platforms were less reluctant to engage in self-video capture. This was evident with participants aged around 25 and below. There was a sense with these (mature) participants that they wished that more videos had been captured as they could be used flexibly for a range of learning uses. Participant 14 demonstrated how a change in strategy from a very text and memorisation-based approach to a more capture-based approach had positively changed their academic success and triggered a transition during their first two years of the programme.

> *Failing first year...there's never a point where lecturer said, "you don't know your stuff" they just say, "we know you know it but you just can't get it out", so that triggered me to change my learning style and since then I've never looked back. I've always been getting 2:1s steadily and coming from failing, that's been good. (Participant 14, Female, BSc, Level 5).*
>
> *If I could change one thing it was that I wish I'd taken more videos in class. But at the start of the year, I tried to…I tried to just remember it, but it's easier said than done. (Participant 14, Female, BSc, Level 5).*

Different types of media were used along with video capture. Students used a range of strategies from visual based photographs, in isolation, with a view to improving memory retention, to using these as a baseline to add further information at their convenience. There were instances where photographs were used to add further details to lectures in which additional content had been included but was not available via slides that were made available to participants e.g., screenshots of slides delivered during a lecture or seminar.

The interplay between video and photographs was also a useful strategy for some participants who used screenshots of assessment and treatment techniques taken from videos [loaded by staff] to study specific handholds and body position for their own skill development. Once again, this helps to dismantle a technique to allow for specific observation and future development. Participant 18 cites an example where a staff video was used to study a clinical skill, but then an image was generated using the screenshot capability of a Smartphone. This image was then imported into Microsoft Excel and used as a baseline to generate a resource. The addition of notes to accompany the specific image was used successfully to better understand the motor skills required to successfully acquire the respective clinical skill. The strategy here was in preparation for a practical skills examination task and was repeatedly used for other relevant content within the module.

> *I would watch them [videos] and then take a screenshot and put it into Excel and add notes to it. I would watch a video looking at hand holds etc that I would need to remember what you supposed to do then I would take a screenshot of it and then save it. (Participant 18, Female, BSc, Level 6).*

Images were frequently used by many other participants to acquire practical skills such as surface marking of anatomical structures or other assessment skills. Participants often completed a surface marking task either within a taught session, or as part of their independent study and then captured the image and applied additional editing to add specific detail e.g., surface anatomy photographs were then labelled with appropriate text using a separate software package. This type of learning featured in many 'core' year 1 modules that looked at particular 'systems' such as the respiratory system or musculoskeletal system.

> *For example, drawing on each other with felt tips and taking photos of certain kinds of respiratory assessment skills that you'd be executing and things. And all them would go into a portfolio online called PebblePad. (Participant 3, Male, BSc, Level 5).*
>
> *But also like for example within the MSK [musculoskeletal] module in first year, the location of anatomical structures and where they are on the body. I took photos of it and kept those for further use so I could understand it more myself. (Participant 11, Female, BSc, Level 6).*
>
> *Using my phone to take photographs I think was really useful because it allowed us to like get those pictures and take them off and put them in a Word document so you can see there yourself. So, I feel it help me quite a lot. (Participant 14, Female, BSc, Level 5).*

The advantage of photographs was therefore multifactorial. It offered an easy method of capturing information that was additional to pre-loaded content available through electronic learning portals and it was easily accessible through the photo album app, therefore could be studied at a convenient time and place. The use of photographs to capture student generated resources e.g., drawing of anatomical structures on live models such as muscle attachments and surface representations were also experienced as positive strategies to enhance learning and understanding. The further development of resources such as these through media editing, labelling and addition of relevant text aided the process through slowing the absorption of information in smaller 'chunks' of information.

It was clear that a variety of influences had an effect on the skill development of the participants. The participatory actions of many participants helped foster a variety of approaches to learning that developed their clinical skills. The influence of mobile technology in this was varied but clear patterns emerged around the development of clinical skills through the use of media-based learning in both a creative self-generated manner and a more consumer-oriented approach using commercial video-based platforms such as YouTube. A pattern was evident that involved initial consultation of public domain type video platforms to develop fundamental skills. These gave a level of detail that allowed more intricate and specific development through staff resources and facilitated a studious approach to aspects such as therapist position, patient position, specific handholds etc. When a level of familiarity was deemed satisfactory, the introduction of self-captured video allowed participants to explore their understanding of specific skills and develop these through a process of self-critical analysis and reflection. The mobility of the learner was also an emergent area within this theme, where a flexible approach to learning environments was often apparent in the data. This ranged from quiet environments such as the University Library to more noisy environments such as the Student Union, or from formal environments such as the University Clinical Skills Centre, to casual, non-formal environments such as lounge and bedroom areas within home settings or when on the move.

Whilst it can be stated that the development of clinical skills mediated by mobile has clear benefits, it must be mitigated and contextualised by the need to be guided by face-to-face contact. Whilst resources such as video offer a degree of simultaneous input and may once again, relate to clarity of explanation from these methods e.g., visual and audio input used concurrently. The ability to see, read and hear simultaneously, offers clarity over a single source such as audio only, however, they cannot always offer explanation or answers to specific questions. The experiences cited by Participant 9 chime with many of the others who value the relationship that is formed from face-to-face contact and give a sense of the limitations of self-created video.

> *Having that contact time with lecturers and seeing the lecturers and those people. So, if you've got any questions you can go and ask; you can go and say hi rather than you don't know… you don't get that same relationship [with eLearning]. (Participant 9, Female, BSc, Level 5).*

Participant 3, whilst being a clear advocate of mobile mediated learning, had some thoughts on the overuse of technology and perhaps advocates a balanced or blended approach to the development of skills. Whilst the development of skills from a motor development aspect is clearly cited by many participants, this perhaps cites reservations on the ability to develop other important skills such as communication.

> *There is an over reliance on technology rather than having social interaction. So, for example, if you are learning MSK, if you are learning practical, maybe it's easier or it's maybe just more… it's just easier for people to rely on technology in terms of…learning how to use crutches appropriately for example. They just look up a video on YouTube rather than interacting with their friends and practicing with an actual person. (Participant 3, Male, BSc, Level 5).*

> *I think that because there is a large …a large scale for people at the moment to turn towards technology and social interaction and movies that can have a detrimental effect on social interaction skills with people being able to build up that aspect by working with another person such as classmate. (Participant 3, Male, BSc, Level 5).*

What is worthy of note with these preferences is that the participants who expressed preferences for contact were mature students, whereas the younger participants were happy to triangulate information without the need for physical face to face contact.

Participant 3, like Participants 7 and 9 were all advocates of mobile mediated learning (all cluster 1 members) but expressed their desire for face-to-face contact to further develop skills.

Participant 16 agreed and, likewise, valued the experiences of face-to-face discussions and postulated that age is a major factor in the acceptance of technology for learning. Additionally, the contextualisation of mobile mediated learning is placed below the value of face-to-face learning.

> *I think it's becoming more acceptable to a younger generation definitely. Medical students do learn a lot of online learning. For me I'm probably old-fashioned and at my age it doesn't substitute being in a seminar and having that discussion. (Participant 16, Male, BSc, Level 5).*

> *I wouldn't use it as an alternative to the practical based sessions, no, definitely not because you can't beat that hands-on experience. (Participant 17, Male, BSc, Level 6).*

These experiences arguably show that whilst a degree of autonomy with learning is inferred from participants, the clarity provided by triangulation of their learning through a number of independent sources is part of their internal preference system. The degree of autonomy with their individual learning provides a freedom to access, explore and develop their own resources and build a strong knowledge base. However, the degree of trust and quality assurance requires epistemic authority to validate their explorations. Whilst the participants value their individual strategies in learning, the contact time with others helps to consolidate and add credibility through dialogue and reflection.

The use of multiple methods of learning refers to participants experiences where learning with mobile devices is used alongside or in conjunction with note taking or note making. The observation was made that often, participants seemingly focus on a particular element of their learning (e.g., skills acquisition via practice), however there may be occurrences which involve both technology and non-technology methods, for example using pen and paper alongside a smartphone, tablet etc. and examples where content is being accessed and where audio, visual and experiential strategies are being used concurrently.

The use of either self-generated or pre-recorded audio content perhaps represents a less well explored resource that learners engage with. Content was commonly recorded (where self-generated) and accessed via smartphone for reasons of convenience. Usually, participants have a smartphone and access to headphones/ear buds etc. hence it is more discreet that a larger tablet or laptop. Its use can be dependent upon the availability of either headphones or quieter environments and allows a degree of personalisation where participants can search and select from a wide range of content through platforms such as 'podcasts', iTunes, Spotify or YouTube (these are available as a standard pre-loaded apps on newer Apple iPhones, or downloadable on older iPhones). When used appropriately, audio files offer a method of capturing detail that can be lost in live situations due to falling levels of engagement. This was a strategy that was used successfully in situations where fine detail was a driver e.g., Participant 4 cites experiences of using voice recordings to supplement material for a module assessment presentation as a useful strategy.

> *For like the Public Health presentation, I'd record myself speaking it and time it and I did quite a lot for it for the MSK presentation. (Participant 4, Female, BSc, Level 6).*

Likewise, Participant 16 used audio that was recorded to their smartphone to good effect. This was used alongside previously written notes to develop a presentation 'script' in advance of a modular assessment. This participant had used a similar approach previously using video successfully to capture clinical skills when rehearsing for a clinical skills examination.

Just listening to yourself just repetition just listening to yourself and as far as I'm concerned it worked I didn't forget anything. For presentations, I probably used the same approach but I'm not necessarily filming myself. It's just again with my phone, I tend to do on my phone and I'll just record. (Participant 16, Male, BSc, Level 5).

Was I going too fast, was I going too slow, was I speaking clearly that kind of thing…I think it allowed me to prepare, to construct it slightly differently because the first time I tried to get it spot on 10 minutes. So, I probably recorded it two or three times before I got the final version to be spot on 10 minutes and then again used the headphones to listen to it, with the word document [alongside the recording] and just went through it. (Participant 16, Male, BSc, Level 5).

it was [staff member name removed] exam where I recorded it on my phone sitting at home in front of my PC with document…a Word document on the PC. When I did the exam that day I watched it on the metro and sat in the lobby with my headphones and used it right up until the minute before the exam. (Participant 16, Male, BSc, Level 5).

The extension from video to a purely audio resource, highlights the influence of different types of self-captured media resources to assist in clinical skills development, but also to develop presentation and communication skills. The ability of media files to offer an alternative to written information when the aim of learning is information retention, is worthy of further exploration by learners as perhaps the level of intensity and opportunity for personalisation merit more attention.

Participant 3 was also supportive of this approach and cited the advantages of mobile mediated learning as offering a different approach to learning due to its flexibility of access. Whilst earlier examples have predominantly referred to media such as video, images and audio to develop clinical skills, this participant also cited experiences of using smartphones to develop clinical knowledge using a specific app on their smartphone. This participant did raise the issue of their own working memory dyslexia and ability to concentrate for sustained periods as an issue within traditional lecture-based contexts, hence recorded audio was used as a pacing strategy where, like video, it could be reviewed and replayed.

The audio learning, the visual learning, it [mobile mediated learning] caters for many different learning styles which in universities' it doesn't, and that's possibly where mobile phones in some respects are more advantageous. (Participant 3, Male, BSc, Level 5).

What benefitted me in that way is that I worked and read at my own pace, which is a very slow pace compared with others because of the dyslexia. It [mobile mediated learning] allowed me to work at my own pace and have that interactive learning. (Participant 3, Male, BSc, Level 5).

The participant also cites experiences of a level 5 module which had been delivered using an e-learning approach. This module encouraged students to 'explore' further suggested resources using provided links. Smartphones and tablets were used by this participant to access modular and further content and develop a series of 'flashcards' using a smartphone app [Anki deck]. This was then used at points through the day to test specific knowledge in a short period of time and could be repeated as often as desired. A self-grading system was used to indicate how much information had been retained.

I can go through as many cards as I like in a day. I can review as many cards as I like in the day I found that's been particularly helpful in being able to recall information quickly concisely. (Participant 3, Male, BSc, Level 5).

This strategy was extended to placement preparation and was valued by the participant as a success. The value of the smartphone was its portability and hence it offered quick, convenient and easy access to the flashcards, without the need for Wi-Fi or cellular network connections.

For a respiratory placement what I do is the same kind of thing, it's a flashcard system on Anki deck and it's help me to remember a lot of certain facts for physiotherapy. (Participant 3, Male, BSc, Level 5).

This, as with the earlier described experiences of using video for clinical skills development in preparation for placement, provide examples of the influence that mobile mediated learning has upon the development of clinical skills and knowledge.

It was clear from the familiarisation process that a variety of influences from prior study had an effect on the resources used by participants. This in turn led to behaviours and choices that had an effect upon the learner flexibility and preferred learning strategies. Some of this resulted from programme assessment strategies and recommendations of teaching staff, however the participatory actions of many participants helped foster a variety of approaches to learning that widened their previous learning boundaries. The influence of mobile technology in this was varied but clear patterns emerged around the development of clinical skills through the use of video-based learning in both a creative self-generated manner and a more consumer-oriented approach using commercial video-based platforms such as YouTube. The mobility of the learner was also an emergent area within this theme, where flexibility of learning environment was often apparent in the data. This ranged from quiet environments such as the University Library to more noisy environments such as the Student Union, or from formal environments such as the University Clinical Skills Centre, to casual, non-formal environments such as lounge and bedroom areas within home settings.

Theme 2. Expeditious Learning.

An emergent pattern of engagement with mobile and fixed technology was noted and demonstrated differing levels of participation and action with regard to finding information. The ability of participants to use technology effectively to access information varied greatly. Many examples were given where social media sites such as Facebook and Twitter were used to find up to date and relevant information. The ability of mobile technology to access these sites quickly and conveniently dictated that smartphones and tablets were used preferentially over other technologies such as laptops and desktops. The ability to stay 'logged in' gave smartphones a clear advantage and allowed browsing to occur in many different environments. These could be whilst in transit e.g., bus, train etc. or could be in non-formal settings such as home accommodation.

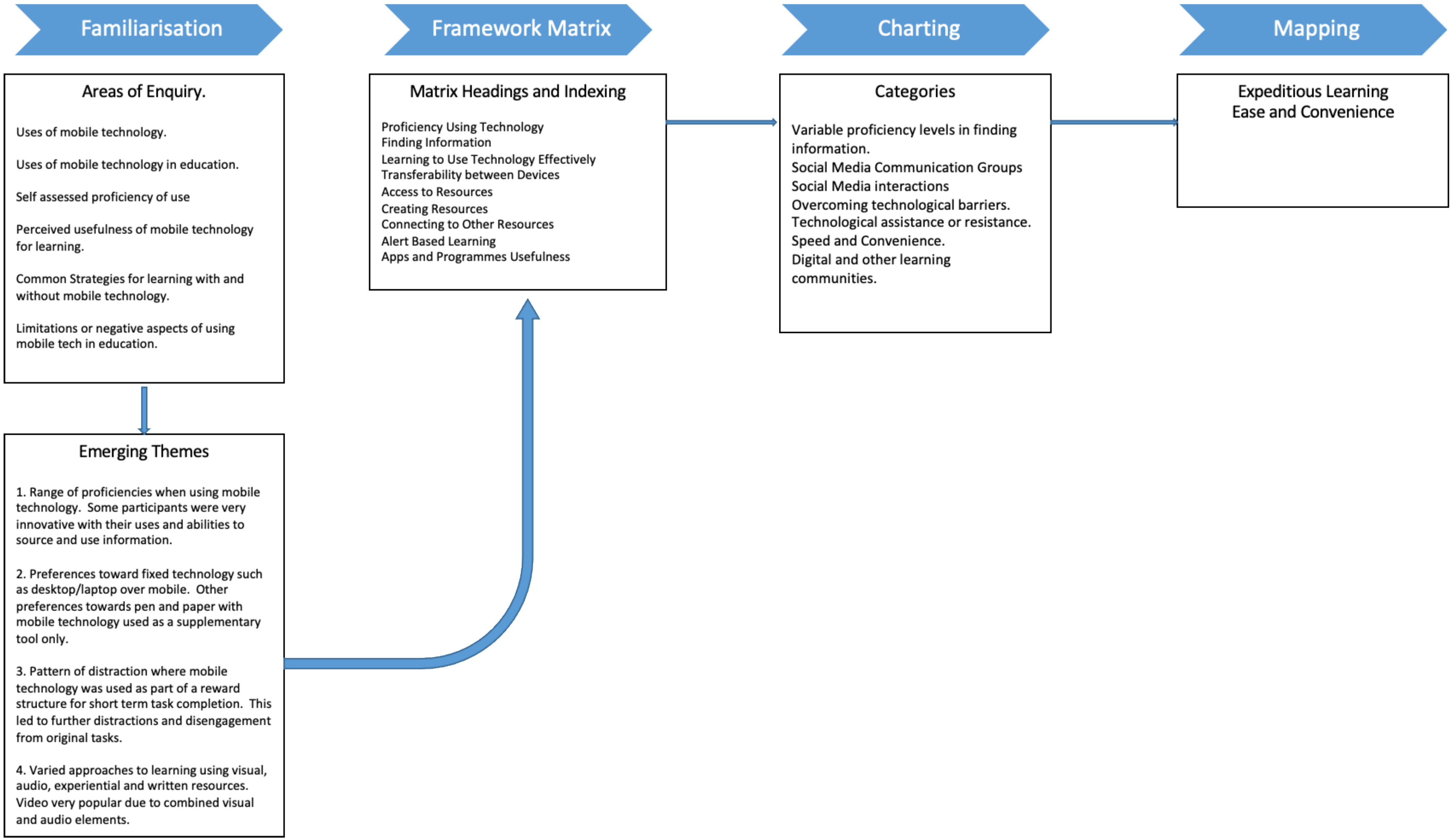


Table 4.31. Development of Expeditious Learning Theme.

Ease and Convenience of Communication

Mobile technology was often described by participants as being easy, convenient, and helpful for learning in specific contexts. Some of these experiences have previously been described where video has been shown to assist the development of clinical skills. Several other experiences were described by participants where the use of mobile technology for learning combined with a flexible learning environment were perceived to be positive experiences. Participants, regardless of age or previous academic background describe experiences where a combination of 'playfulness' with mobile technology led to successful strategies being devised and these were found to be extremely positive. Several participants describe that mobile technology was convenient to use and facilitated aspects such as the speed of information retrieval and speed of response.

The convenience can be partly attributed to a combination of the learning environment, the development of key learning strategies and the technology as participants were able to study in a relaxed atmosphere and in a non-formal manner e.g., bedroom, lounge etc. This combination of ease, speed and convenience can be described as an expeditious approach to learning where participants value the ability to find and locate information easily and quickly. This can be in a variety and combination of approaches. Participants frequently describe occurrences where they were able to source information through mobile technology, using platforms such as social media to find contemporary evidence around subjects where information from traditional texts was sparse. Social media was described by a number of participants, who used this medium to find information quickly through communication apps such as WhatsApp and Twitter. The most common way of accessing this material was through their smartphones. These 'apps' were used both to find information and also to share some of this information with their peers. Participants 12 and 23, describe scenarios that were commonly cited, where links to physiotherapy skills or theory were sourced and then shared with others using various social media platforms (Facebook, WhatsApp).

> *If I went to my Facebook messenger history, half of it would be each other sending links, quotation or pictures and things. I think that goes on a lot in terms of…so that's a big aspect to. (Participant 12, Male, BSc, Level 6).*
>
> *There was three of us doing the videos and the pictures as well…. sorry just the pictures and we distributed those out through WhatsApp to each other. (Participant 23, Male, BSc, Level 5).*

Participants commonly established "group chats" on social media apps and then used them in a combination of ways. Group chats varied from large cohort group chats where most members of a cohort participate as members was cited by many participants to smaller peer working group chats. The larger group chats were used positively, to exchange information in a more question and answer-based approach. The positive aspects of this are that answers to questions could be found quickly, as members of the group were likely to respond within a short space of time. The public nature of this cohort information is that all members of the cohort (if they have joined) can see what questions have been asked and see responses to the questions.

> *As a year group I'm with, there's a group chat and we'll put things in there. Somebody might ask a question in there and sometimes people get back to you and sometimes they won't but that's quite helpful. So, the social media side of things, it's quickly accessible where you can ask your peers and things. (Participant 23, Male, BSc, Level 5).*

Questions commonly had been answered by academic staff but not then memorised by participants. They could relate to assessment task clarification, hand in dates, links to useful sites, etc. The rationale for this approach is that it was often faster than accessing the answers through Blackboard or emailing academic staff, therefore appealed to participants. They have also facilitated and given rise to differing types of participants. Some, who are consumers and tend not to be contributors, and others who are more regular contributors and 'influencers' in the context of the whole year cohort group. These participants happily shared their thoughts, opinions, experiences and in some cases, resources that they may have accessed or created, with the rest of the group. Others such as participant 17, felt that they did not need to contribute to feel involved in the group.

> *I don't need to feel the need to be involved or vocal in that communication [WhatsApp] I still feel part of it, so you are still in the loop. (Participant 17, Male, BSc, Level 6).*

Smaller group chats were also established in which close peers participated and these served as useful information exchange sites where participants negotiated work-based tasks and bodies of work that generate larger files can be shared using other more convenient methods e.g., email, cloud etc. Participant 22 clearly cites the function of their particular group to be a working group rather than a social group and that this chat group was the method and platform of choice when communicating about programme related questions amongst peers.

> *We made a little WhatsApp group then. I think it started as 7 or 8 people and then slowly we added loads of people, but it means it's less of a social group it's more of a workgroup (Participant 22, Female, BSc, Level 5).*
>
> *For study, I would definitely use WhatsApp more, because there's a big physio year group and there's another with about 8 to 10 of us in. So, I'm more likely to message the smaller group for most of my questions. (Participant 22, Female, BSc, Level 5).*

Participant 19 describes a very similar approach and rationale for the use of small WhatsApp groups to participant 22.

> *So, we have a group on WhatsApp with 5 of us from uni [university] and we use that to talk about assignments and exams and things (Participant 19, Female, BSc, Level 4).*

Experiences differed as to why participants would or would not share answers or resources with the group, but often, the decision not to share resources was reported as a fear of being judged within the macro-culture of the group. Participants refrained from sharing resources with others outside of their own peer groups or the online community but were happy to share in their own micro-cultural group chats.

> *I wouldn't engage in it with all courses [large group] such but with my own group, I would have if I ever had a question. I wouldn't be scared to share something with somebody else or ask it or I wouldn't be scared to answer somebody else's question if they had a question about something. (Participant 5, Male, BSc, Level 6).*

These communications were reported to be a positive experience due to the collaborative relationships that they helped establish and for the learning that occurred as a result of sharing their resources with each other. Mobile technology provided a quick and easy to use method, for providing easy access to, or sharing of resources. Neither sharing of links nor communicating required a large degree of digital literacy, hence they were popular methods amongst the sampled participants. Tablets and Smartphones were the most commonly cited means of access to WhatsApp, Facebook and Twitter. These apps, gave a degree of control and autonomy when selecting, accessing and sharing information and hence complemented the learning strategies of individual participants. Whilst these experiences are reported as being positive, it is accepted that negative stigmas were also associated with technology.

Whilst video-based learning was generally accepted as being very useful long termly, the initial experiences of interacting with technology for this purpose were in contrast with the perceived usefulness. Some learning experiences were also cited as being labour intensive due to the need to use at least three people. Participant 15 gives an example of this during a video capture session for self-created anatomy resources. This involved one person to act as therapist, a second to act as model and a third to act as the individual capturing the video.

> *we tended to work in groups of two or 3 to get those videos and it's really difficult to put it all and put in selfie mode and get a skeleton standing there and working through all the bones and making sure you can get the ankle and the foot and the head and things, so you needed some support there. (Participant 15, Female, BSc, Level 6).*

Ease and Convenience of Environment.

The flexibility of learning mediated through mobile is reflected by the range of environments in which learning was said to have occurred. Learning environments could be viewed as those in which formal learning occurred with staff members in attendance, and those that were less formal. The less formal learning could still occur in formalised environments such as classrooms, practical rooms or library settings, however, were described as less formal as the staff members were not in attendance. However, some less frequently expected environments also featured prominently in the experiences of participants.

Whilst learning through mobile technology in home environments were described extensively by participants, these ranged from formalised areas where 'home offices' had been arranged, to more relaxed contexts such as lounge and bedroom spaces. The home office descriptions were usually more mature participants who had previously studied at degree level or had gained 'life experience' through previous employment. The separation of working and living spaces was also linked to their preference for technology, with often desktop or laptop technology rather than through mobile presiding in these areas.

I tend to do everything at home, and I don't tend to do any learning on the go. I have a desk area and a workspace, and I like to keep that separate if you know what I mean. (Participant 18, Female, BSc, Level 6).

I found I was doing my Access course I had my desk in my bedroom and there was no separation and it just from this I thought I need just to have one room that I work in and then I can switch off. (Participant 18, Female, BSc, Level 6).

Younger participants gave more frequent descriptions of learning in bedroom space and lounge areas with more portable mobile technology such as phones and tablets and generally described their reasons for this as, offering a more flexible option as it offered a very 'easy' and 'handy' method of learning in a relaxed environment. This ranged from accessing the electronic Learning Portal (eLP) to peruse lecture slides ahead of scheduled lectures, thereby allowing a more thorough preparation of content, to accessing timetables and library accounts.

Again, easiness it is just easier to turn it on [tablet] and I can lie down and read something, so I am taking a lazy approach there (laughter) I feel like I am still studying but I am comfy lying down. (Participant 11, Female, BSc, Level 6).

Participant 17 gave an example of using both an office environment which was predominantly used when using a desktop or laptop but used a tablet to access other content in a less formal situation. The difference in approach was dictated by the aim of the particular session e.g., the iPad in this case was used to view content such as video, ejournal etc. whereas the use of the laptop, desktop was also linked to viewing video but also to creating documents such as assignments, notes etc.

It depends where I am in the house as I've got a little office setup, but with my PC, so I tend to use that to watch YouTube videos but if it's if I've been at university for the day and I've *sat on the couch and I'm reclining on the couch then it would be the iPad that I would use. (Participant 17, Male, BSc, Level 6).*

Access to resources such as lecture slides was a commonly cited activity as well as transcribing more detailed notes from personal audio equipment that was used to record lectures.

The productive use of time when travelling was an unexpected aspect of mobile mediated learning and was the most frequently cited experience of a mobile environment using mobile technology. The nature of this varied from when traveling on public transport services such as bus and trains to using time waiting for family members in car parks. Many examples were cited where participants used mobile technology during short periods of travel time (usually during bus journeys) to re-familiarise themselves with content or practical skills. Content ranged in nature from lecture slides to flash card use and was commonly cited prior to attending a formal face to face lecture where slides were made available before the lecture took place. Smartphones were by far the most frequently cited form of mobile technology for this type of learning, primarily due to their small size and portability over the slightly larger and more cumbersome laptop.

I be travelling on the bus or something and everybody would quickly, you know, I'd get on my phone and have a quick skim over [lecture slides]. (Participant 2, Female, BSc, Level 5).

Concerns over security of personal items was listed as a concern by Participant 20 and that it was more 'normal' to see people using a smartphone on public transport such as buses, whereas laptop use was more commonly associated with longer journeys where a more meaningful amount of time may be spent on a task.

I think on trains, people take laptops out and airports they take laptops out. Buses less so. I think in general I prefer not to take my laptop out because a) less people do it and b) it's a silly reason as it were, but I don't like displaying the valuables that I own. (Participant 20, Male, BSc, Level 6).

it's normal to see an iPhone in somebody's hand [on a bus journey]. It's far more so than you'd see somebody holding a MacBook Pro, so people are more likely to target you…for example, theft. (Participant 20, Male, BSc, Level 6).

Train journeys were cited as opportunities where laptops and tablets could be used more productively both for revision and also for document creation. Both were more frequently cited as better to work with on longer journeys. Smartphones were often cited as being less satisfactory to work with, and possibly their advantage on shorter journeys is due to the space limitations of buses or possibly due to the increased and more frequent number of stops or more frequent changes in passengers, meaning that less settled working environments suit smaller technologies. Participant 13 perhaps summarises this whereas Participant 9 develops this by qualifying how a train journey afforded the opportunity to prepare for a presentation using a laptop rather than a smartphone.

On the train I can do it on a laptop. I would never bring my laptop where I could bring my iPad because it's just much smaller. (Participant 13, Male, BSc, Level 5).

I would mainly make my revision notes on that [laptop]. I use it on the train for the first time the other day. Because I could make some revision notes on the train in Word. I used it for the presentation that we had for public health. (Participant 9, Female, BSc, Level 5).

A minority of participants did however cite longer journeys such as train journeys as a convenient opportunity to access content through mobile. This was cited by participants who had a good knowledge and awareness of technology and were comfortable with their ability to set up a system that allowed them to access resources from a variety of locations e.g., when on the move. Participant 1 was an early adopter of mobile technology and had set up a cloud-based storage system to upload various materials. Using a tablet, they were then able to access these resources from anywhere that offered an internet connection either through Wi-Fi or a cellular connection.

> *It's incredibly accessible you know. As I've said, I might be using it on a train, I might be sat waiting for the train, I might be in the library and I might be at lunch. If I've got access to the Internet, then it means that I've got all of them resources open [on a tablet] to me whereas I'm quite restricted by a desktop. (Participant 1, Male, BSc, Level 6).*

Whilst both public and self-created video was used extensively to develop clinical skills, it was not commonly cited as a convenient strategy for learning whilst travelling. One participant cited reasons for not watching video were due to being fearful of missing their bus stop due to being engrossed by the video content. Only one participant cited using video as a strategy in a mobile environment (waiting for their children, whilst parked in a car park), however, participants often describe using the audio aspect of saved or streamed videos to listen to content. Participant 14 describes how this was through the use of their own mobile phones and audio was delivered via earphones, thus it appeared that participants were listening to music as they did not view the screen. These referred to journeys where the participants were not traveling with their peers. The reasons stated for not watching videos whilst on public transport were usually due to not wanting to appear anti-social to other commuters and that there was an assumption that watching video was anti-social, however their own belief was that appearing to listen to music through earphones was more socially acceptable as their smartphone was out of sight.

> *I would listen when I was going for the bus or going to university, I would be listening to it and I would be getting it into my head all the time. I wouldn't really take (watch) a video of somebody doing mobs on the bus or stuff like that. I just tend to listen to it on my phone. (Participant 14, Female, BSc, Level 5).*

The use of social media as a search engine was an area of variability within the sample and was a key factor in dictating the length of the interviews. Participants whose interviews lasted longer, were the participants who discussed their use of social media in much more detail. This appeared to be an area that drew a line of distinction between more digitally and information literate participants, from those who were less literate in this context. The additional interview time with these participants reflected that the semi-structured nature of the interviews was appropriate as it allowed the interviewer to 'probe' these areas in more detail and to provide rich in-depth data around the approaches to information gathering and evaluation. Strategies used ranged from using the 'search' function for specific searches around key words e.g. 'shoulder physiotherapy' and then simply 'following' selected accounts within Twitter, recommendations from peers, staff etc. to engaging in actual dialogue through the use of the comment/conversation option. This did result in replies from the account holders in certain situations. Participants had a number of people or organisations/charities who they followed with the aim of accessing content posted by these accounts. Often the information was cited as being more contemporary than from books, journals etc. and hence was a valuable sorce of contemporary information.

Participant 17 cited an account that was followed as a source for a final year academic written assignment around palliative care, and found the contemporary evidence in text books and journal articles to be very dated. The use of this Twitter account led the participant to a rich source of contemporary peer reviewed physiotherapy evidence that was used very successfully (participant received a mark of 70+% for the assignment), to complete the written task.

> *I searched for palliative care and just typed it in and found with that particular thing, I maybe found 10 to 15 people from around the world who were palliative care specialists and were in a practice here or a hospital or there and it was feeding in real-time stuff into my assignment not something from a book that maybe was 10 years old. (Participant 17, Male, BSc, Level 6).*
>
> *I'm not even sure I was really influenced by Twitter but it is kind of sowed a seed really and then I realised... hang on I can find out about lots of things so an assignment on palliative of care I thought I realised I could follow a palliative care group and that would fit into the way that you think and that could fit into an assignment so I think that Twitter is massively useful and because it's linked to journals that are peer reviewed it's not just tittle-tattle on the Internet it's peer reviewed and it's a great form of learning. (Participant 17, Male, BSc, Level 6).*

The irony of this approach is that, whilst higher levels of literacy were observed in participants who used this approach, the returns required little work other than reading and evaluating the delivered content. Initially, using this aproach requires 'setting up' the initial account and selecting the initial accounts to follow, the information would then be 'delivered' to the participants 'feed' [posts that are automatically delivered to the participants account] for appraisal. Hence, for a small amount of initial outlay in terms of time invested, the information returns generated appear to be worthwhile and experiences from participants suggest that this was the case.   Their experiences were that delivered content via a newsfeed represented a convenient way to receive content of their choice through 'following' or 'subscribing' to various contributors' channels or accounts.

> *All it takes is a quick click on your phone and you're following somebody and any kind of news or any new research that they're posting it tends to just pop up on my feed so, I follow a couple of people that have worked with in the past that I follow on Twitter and then often I will retweet things that they have read. Something that I would never have probably gone out to look at. (Participant 15, Female, BSc, Level 6).*

Convenient learning environments mediated through mobile such as this were cited by other additional participants as useful strategies, but what was striking about this was the emotion with which participants spoke. Often, they spoke with a real passion about discovering this type of learning and a sense of achievement seemed to preside. It appeared as though they had not just learned theoretical content but had equipped themselves with a new skill that would enhance their future studies. The key to this type of learning once again was accessibility to the internet, an awareness of the skills needed and an awareness that resources could be accessed in this way. Participant 7 describes how this is often not part of University guided content but is an additional strategy that was discovered and developed through the programme.

> *I know when you come to university you have a think about how to use the ELP but the first few months is trying to just get your head round navigating eLP but no one tells you about other things. (Participant 7, Female, BSc, Level 6).*

Participants 4 and 7 describe how accessing Twitter through a mobile app was a fast and convenient way to access content to a physiotherapy contributor's material [in this case, Tim Watson].

> *but that was a fast way of doing things [mobile Twitter] I think and a good way to get different information rather than having to go on his website and go on scroll through the different things. (Participant 4, Female, BSc, Level 6).*

Another feature of this approach was described where participants checked social media feeds without the intent of engaging with learning, however, certain posts within their news feeds then triggered non-formal learning. Participant 7 cited experiences where the links within the feed then led to further connectivity through internet searches, peer reviewed articles and/or comments posted in response to the original post or in response to other aspects of the post e.g. article, video etc.

> *So, it is not something that I would like, sit down and say, "right I am going to spend an hour just going on Twitter". It is a thing that enhances my learning because it's a thing that I can do while I am having a coffee, or I can say while I'm waiting in the car park or something. It is something that I can access on the go and that's what I like about that type of thing. That's what I like about Mobile actually, that "now". (Participant 7, Female, BSc, Level 6).*

Some participants had certain reservations about the validity of the sources, however, in line with digital literacy definitions, the more literate participants were happy to use these resources and had established the peer-reviewed nature of the sources. Participant 1 expressed opinions about using Twitter as an information soure due to concerns about the quality of the content that is published there.

> *I kind of am a little bit of a stickler if I'm honest when it comes to social media. Because I think it's very very easy for people to put quite poor quality or even biased methods. So, I think these things have to be taken with a pinch of salt. You have to know the quality of what you are looking at. (Participant 1, Male, BSc, Level 6).*

A much less frequently described experience was the interaction with wider audiences online, where participants interacted with regional or international communities through digital platforms. A much smaller number of participants reported that they had engaged with established practitioners both in the UK and internationally. This engagement with a more global community was seen in participants who during the interviews disclosed their learning difficulties around content delivery in more traditional settings e.g., through lecture and seminar type activities. The engagement with these digital communities, perhaps allows time for content to be absorbed and for questions to be constructed with more deliberation than would be expected through classroom discussion or through oral-visual type presentations. Participant 14 experienced difficulties in their first year of the programme and ultimately, repeated the year. Pacing strategies have been raised as part of theme 1, however the interactions between participant and members of a global digital learning community such as Twitter perhaps offers more qualitative evidence of the importance of thinking time and reflection in the context of learning.

> *On Twitter there's actually a really good person who I follow, and I can't remember his name but if there's any questions that you have, you just asked him that and if there's a question he'll always get back to you. (Participant 14, Female, BSc, Level 5).*

The ability that mobile technology provides to access social media sites quickly and conveniently dictated that smartphones and tablets were used preferentially over other technologies such as laptops and desktops for learning purposes in this respect. Social media sites provide a convenient method for participants to access information from a wide range of sources and offer communication and collaborative opportunity. The portability of mobile technology, in particular, smartphones, offer the opportunity for an adaptive form of learning to take place in a range of contexts and environments, both static and whilst on the move. Social media sites such as Facebook and Twitter offer a choice between laptops and mobile technology, however when this was presented, the decision was dependent on the size of technology and length of the journey. The ability to stay ‘logged in’ gave smartphones a clear advantage and allowed browsing to occur in many different environments when time was limited. These could be whilst in transit e.g., bus, train etc. or could be in non-formal settings such as home accommodation but it was the speed, ease and convenience of mobile mediated learning that primarily influenced the learning in bite size pieces.

Theme 3. Barriers and Distractions.

Whilst the acceptance of technology models has roots in the ease of use and perceived usefulness of the relevant technology, this study will now present some of the barriers and frustrations that were experienced and encountered by participants. These findings help to partially explain why some participants were less strongly influenced in their own learning by mobile technologies and perhaps present the idea that whilst mobile technology may not always have been a primary source, the data suggests that participants were not anti-mobile technology, but simply that other technologies were used preferentially. This theme will present some of the other barriers such as financial considerations and the limitations of aspects such as data plans, battery life and the limitations in screen size offered by more portable technology. Many of these codes are inherently related as aspects such as limited mobile phone data plans are linked to the ongoing financial constraints, or that battery life and storage space are linked to the financial barriers imposed when faced with upgrading 'ageing' mobile phones. The diagram (next page) details the development of this theme from the familiarisation stage through to final mapping of the theme 'Barriers and Distractions.'

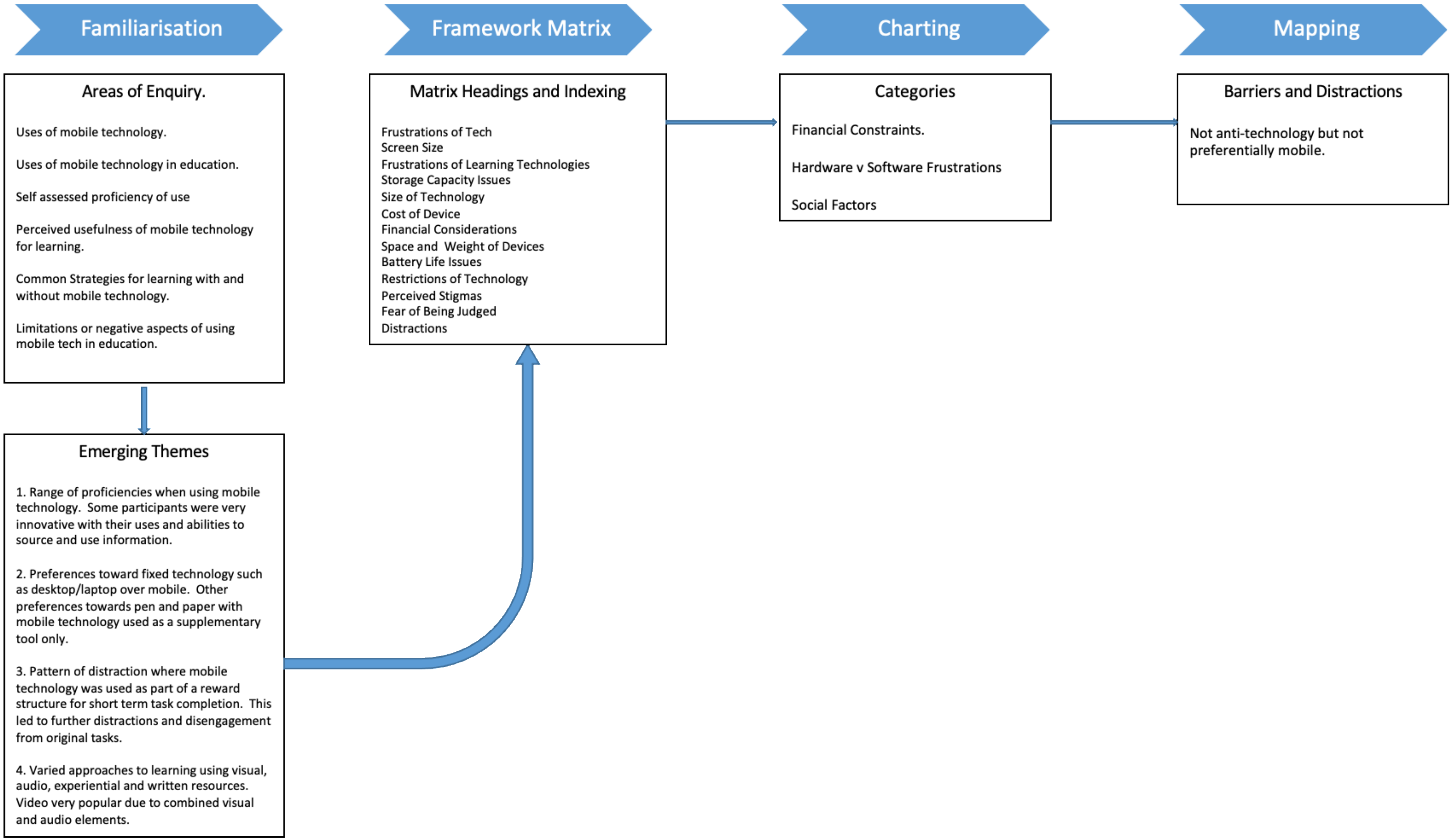


Table 4.32: Development of Barriers and Distractions Theme.

Financial Constraints.

The cost of mobile devices was cited as a reason that participants did not own other mobile devices other than a mobile phone. The decision of whether to purchase an additional mobile device or a laptop, generally came down to cost, the flexibility that the device offered e.g., some laptops doubled as tablets, and preference for a particular brand. A laptop was cited by some participants as offering more flexibility in file structure and offering a better viewing experience. This dictated that some participants preferred having a laptop over a second device such as a tablet. Some participants described devices that doubled as both tablet and laptop; hence these offered a halfway alternative. Participant 16 cites this financial aspect as a primary reason alongside the ease of use of the device.

> *I bought this one because it's easier to use and it doubles up as a Tablet so I can watch movies on it and things like that. I didn't really put much thought into it and it was more of a budget thing. (Participant 16, Male, BSc, Level 5).*

The high costs of tablets were a factor for why participants chose to avoid purchasing this as an additional device. Other reasons were cited implicitly that indicated the high cost of screen repair was a factor in the decision to purchase a laptop over a tablet. The implicit interpretation here was that the tablet screen was more easily damaged than the screen of a laptop and therefore offered a 'safer' choice. Participant 14 cites this as a negative experience due to suffering a broken screen and was more reticent about future purchases of a similar device.

> *It was going to cost a bomb to get it (screen of mobile device) fixed. (Participant 14, Female, BSc, Level 5).*

Early adopters of mobile technology such as Participant 1 however, were very passionate about the value of tablets and believed that the financial costs associated with these devices prevented more learners from exploring their potential benefits, or the perception was that tablets only offered benefits for certain types of learning across a limited number of modules e.g., visual interactive apps such as anatomy apps, and hence the cost therefore did not justify the learning opportunities. Participant 1 had previously developed skills of literacy and had set up a network that allowed upload of files to a cloud-based storage area and was able to access files from anywhere. This effectively freed up space on their device, so storage space was less of an issue. Participant 1 also advocated the use of this type of technology to fellow house mates as an efficient and effective tool for learning.

> *I think that there is a lot of people, a lot of learners that might miss a potential opportunity because they maybe don't have the… it may be the financial cost that maybe prevent them from being able to obtain a device that would be beneficial. (Participant 1, Male, BSc, Level 6).*

This to an extent is supported by Participant 5, who doubted that the value of a tablet would not add significant value to their learning and could not justify the financial outlay of a tablet to assist with a single module.

> *Also, I suppose financial things, like, loads of people would only have a laptop and it's a big laptop and you don't want to go into further debt and buy another tablet because they think it might help them learn naturally for 1 module. (Participant 5, Male BSc Level 6).*

Participant 7 had purchased a tablet but did not see sustained value in bringing their tablet to University with them and cites the advantages of a tablet to be no better than those offered by a smartphone. This statement relates to the transition from year 1 to year 2 and the use of video capture for clinical skills development. The use of a smartphone for video capture of skills is more frequent during year 2 and more convenient when using a smartphone.

I used to bring my tablet with me, but I don't now because everything is on my phone, so I don't see the point. A tablet is more expensive, and it takes more space, so I just leave it at home. (Participant 7, Female, BSc, Level 6).

Hardware and Software Issues.

Storage Capacity Issues.

The issue of storage was a frequently cited problem amongst participants and was most often described when discussing video capture for their own clinical skills development. Theme 1 describes how the use of video capture; image storage and audio capture were used to develop clinical skills. Video files in particular are large in size and, dependent on length, can exceed 1Gb in storage. The issue of storage capability on a smartphone was hence cited by many participants to be a barrier for the use of mobile mediated learning. This issue was partly linked to the financial consideration sub theme as often, participants owned phones that had storage capacities of 8GB or 16GB, due to the lower cost of phones of this type when compared to larger capacity phones such as 32Gb, 64Gb or 128Gb. Participant 10 describes a common scenario encountered when capturing clinical skills content on a smartphone.

I have tried to film different things on my phone but it takes up so much storage and storage is a bit of an issue on your phone. (Participant 10, Female, BSc, Level 5).

Participants also cited issues of stability when using smartphones with lower storage space and described issues such as phones crashing or software malfunctions that result in a loss of data e.g., video footage, photographs.

This phone it just won't take any more videos or if I do use it and I try to upload it somewhere so I can keep it, and it takes about an hour and always crashes in the middle. (Participant 9, Female, BSc, Level 5).

And you rely on like software of something to stay open and it could close any time and then you're stuck, and your stuff can be lost. (Participant 8, Female, BSc, Level 4).

Participants 8 and 9 describe how these present a barrier to the use of mobile technology for learning in contexts where large amounts of data were required. The storage of a smartphone was often used for personal reasons e.g., personal photographs etc. hence using storage for non-personal reasons was viewed with a degree of negativity. Some participants did have strategies to deal with these issues and used cloud storage to upload content to and then free up space on the phones, however differing levels of digital literacy existed, hence whilst solutions were available, these were not always utilised. Participants who believed that storage issues were a barrier often di not possess the knowledge or skill to deal with this problem. Participant 22 was unable to engage with this type of mobile technology in the same way as those participants with larger storage capacities due to restricted storage and was unable to find a solution to the problem, hence was not a prolific user of mobile mediated learning.

> *My phone doesn't really have any memory even though it has hardly any pictures on it. It always tells me it's got no memory so I can't really record much. It's storage. I don't really know how to use it. I don't know how to sort out the storage quickly by deleting things. (Participant 22, Female, BSc, Level 5).*

This participant valued the use of mobile mediated learning through video capture to develop skills, but unfortunately was unable to engage with it as they wished due to the storage barriers outlined.

Participant 4 was able to find a partial solution to this by collaborating with peers who did have more capacity and then shared files in other ways, e.g., file transfer, however, were unable to share these files using their smartphones. Whilst storage was an issue for these participants, they did not express negative attitudes towards mobile technology, simply that they were unable to engage as they would like and had developed alternate strategies as a result of these limitations.

> *We did it [video capture] on our phones or we used XXXXXX's iPad but then I did it on my phone if I had enough storage, but storage was an issue. (Participant 4, Female, BSc, Level 6).*

Frustrations of Technology.

Whilst physical storage to hold files on the mobile device was cited as a barrier to using mobile technology, the lack of data to access files represents a related but different issue. This barrier was described in contexts where access to files is dependent upon 3G or 4G networks (e.g., where Wi-Fi is not available) and an available data allowance that gives access to these resources has been exhausted. These situations were described when mobile devices were used where the learner was mobile and in transit, often in situations where they were out of range of Wi-Fi networks or a public network was running slowly.

Experiences included access to University email accounts through a mobile device where participants had set this up to 'push' messages to their phones and access these conveniently for organisational or informational purposes. Participant 4 described situations where messages either failed to load, were slow to load or experienced incompatible file types.

> *I think it's frustrating when things aren't loading. So, with my emails and stuff, if I can only see four emails. it's a bit annoying so I've got to go through the process of logging on and doing it on my laptop which takes out the efficiency of using it on your phone. (Participant 4, Female, BSc, Level 6).*

The rationale for using a smartphone in this situation to access emails is that it is a much faster method. Using a smartphone avoids the process of start-up delays and login processes that accompany the use of a laptop. Whilst this is not always necessary and certain laptops do not need this process when they are reopened, it was the reason that participant

4 cited. The emails in this scenario included attachments sent by University staff or peers who were sharing files and using email as a vehicle for collaboration.

Participants 12 and 14 cite similar issues but cite the speed of receiving the email as a barrier to future use. The speed of reception may be for a number of reasons including speed of the cellular network wi-fi speed, size of the attachment, number of people online etc. Participant 14 implicitly hints at the cellular network speed and thus their personal data plan as the cause, as the attachments open when within range of a wi-fi signal.

> *So, if I'm waiting on an important email with an attachment I have to wait until I'm near a device or if I'm at home (University term time address) to open it or in the library, I might have to wait until I'm home to open it so I just find it really is so annoying. (Participant 14, Female, BSc, Level 5).*

> *What I find the most frustrating thing is I can't open the attachments on the Android straight away. (Participant 12, Male, BSc, Level 6).*

As has been mentioned frequently, the use of video footage through YouTube was highly valued, however the lack of a good data plan led to frustrations in situations where access to this platform was via 3G or 4G. This effectively limited participants to Wi-Fi based access and effectively presented a barrier to the use of mobile learning where this was not available. Both participants 8 and 22 cite the data plan as the reason that they were unable to engage with certain videos that assist in skills development whilst away from a wi-fi connection. Participant 12 cites the lack of data to be a barrier for using mobile technology in an easy and convenient manner.

> *I suppose you can use Wi-Fi anywhere whereas on a mobile, 3G and 4G runs out and you don't have any data left to do your work on the go. (Participant 8, Female, BSc, Level 4).*

I'd also use YouTube when I have Wi-Fi but I don't have that much data on my phone so I couldn't, I wouldn't just be looking up YouTube videos in class. (Participant 22, Female, BSc, Level 5).

I don't have a good data plan for these so I wouldn't use on the train on the bus. (Participant 12, Male, BSc, Level 6).

A slow connection speed was not limited to data plans as other participants cited a slow wi-fi connection as a barrier. Similar to slow data transfer, this led to a sense of frustration, which led to development of other strategies that were faster. Participant 7 shows how a better data plan was more effective than a slow wi-fi connection and thus was able to access resources through faster 3G or 4G networks.

Well, we haven't got very good Internet access at the minute with decorating and it is just a little bit redundant. So, it's my phone that does everything. (Participant 7, Female, BSc, Level 6).

The lack of a high-speed connection or instant access to resources thus created a barrier to the use of mobile mediated learning. Much of the frustration arose from the belief that areas such as video capture or information exchange of personal skills was valuable to personal development. The ability to access content in an easy and convenient way whilst on the move was also constrained by the lack of a good connection, hence these were factors that contributed to limitations in use for this type of learning.

Whilst some of barriers that have been considered have presented hardware issues such as physical memory or data issues such as a low-capacity data plan, there were further experiences described by participants where mobile technology presented a technical barrier to their use or that the physical handling of the device presented problems. These included firstly the human resources element of capturing video footage where 3 people were required to participate (patient, physiotherapist and cameraperson) for later review or, secondly, issues of incompatibility when accessing resources. Incompatibilities usually arose when the original device that had captured the source file e.g., a video, recorded this in a format would not allow the smartphone or tablet of the participant to display it. This occurred both with footage captured by peers and by academic staff. Experiences were described where the smartphone of a participant and their data plan connectivity was sufficient to access these resources, however, incompatibilities between their own personal devices and the resources, prevented the resources from opening correctly or in certain cases, not at all.

> *In terms of the videos that you provided for us for module the videos and things will not play on all tablets and devices. (Participant 5, Male, BSc, Level 6).*

Participant 5 recalls how they found a solution for the compatibility issue through the use of the Citrix Receiver app which acted as a bridge between different file formats and allowed footage to be displayed, however the quality of the resulting video and audio were poor.

> *Citrix reader is so… well it is a blackboard software thing it is not very pretty looking at all…and it's basically just like a slow computer in your hand. You could play them through that, but you couldn't enlarge it and the quality was horrible. The audio was even worse. (Participant 5, Male, BSc, Level 6).*

These experiences e.g., using Citrix/Blackboard combinations were cited as examples that ultimately led to participants not engaging with the technology due to a perceived difficulty in using this option and poor definition quality. Participant 5 was a strong advocate for mobile mediated learning and cites many advantages of smartphone and tablet technology to assist learning. They possessed skills to overcome many technical barriers and had developed strategies to enhance their learning experience when using tablets e.g., purchase of a Bluetooth keyboard to increase available screen size, knowledge of how to split the screen of a tablet, consistent technological ecosystem (i.e. all Apple products), uploading of files to cloud to increase storage capability etc. hence the frustrations experienced by the barrier of file incompatibility was one of the strongest reasons that participants chose not engage with mobile mediated learning.

The differences in operating systems between mobile phones and PC based computers dictated that some resources were not created in a mobile-ready format and hence proved difficult to access without compatible software. This once again has some links to the digital literacy of participants as some 3rd party apps had the capability to play these resources, or they could be saved to cloud based storage and viewed through cloud drives via 3rd party apps.

> *Some of the videos still don't work or the files don't fit to your phone properly or the Word documents are hard to read. (Participant 4, Female, BSc, Level 6).*

Screen Size.

The context of small or large screen size relates more to the use of smartphones rather than the bigger mobile tablets. The portability and convenience of video capture using a smartphone is slightly mitigated by the disadvantages offered by smaller screens. Whilst convenience and ease of use were highly valued traits of mobile devices, a good viewing experience is also necessary to study or review skills that have been captured. This was also a factor if documents were appraised suing a smartphone. Documents such as lecture notes or PDF articles, word documents etc. were all referred to by participants who had tried to view these through a smartphone. This was in a range of different contexts, as some described using their smartphone to view slides whilst in a lecture, where others had accessed these either at home or whilst in transit. Participant 9 describes the difficulty in reading lecture notes and slides on a smaller screen as a barrier to using a smartphone for this purpose.

> *I want to look at lecture notes but if anything, I find it too small on the screen and not very helpful for reading…reading more than a few paragraphs or a quick definition. (Participant 9, Female, BSc, Level 5).*

This was found to be more exaggerated if the document on screen had multiple pages and thus participants would need to scroll up or down the document. Participant 10 describes the laptop as being a much better tool for this due to the bigger screen and better control of the document position on the screen. The difficulty in reading smaller text presented a major barrier for smartphone use in this situation.

> *I think more than anything the laptop is a bigger screen where is the phone is a tiny screen and you can't see much and you're scrolling all over the place just a kind of read anything or look at anything so I think just the ease of having a bigger screen rather than not being able to do anything on a mobile. (Participant 10, Female, BSc, Level 5).*

Hence the small screen nature of a mobile phone was viewed as a barrier from a number of areas. The ability of participants to find solutions to these problems e.g., finding alternate technology, is influential as files can be forwarded, screen cast to bigger screens or transferred to allow a better viewing experience. Devices that allow easy file exchange between them were frequently used e.g., within a homogenous Apple Inc. or Android ecosystem, however as participants used both phones, tablets and laptops for video capture, it is unclear if these were then transferred or simply viewed on the original device.

The small screen of a mobile phone was also described as being difficult to navigate and scroll due to the limited information that could be displayed on the screen, hence it was used within a limited timeframe to access lecture notes other word documents. Some participants described the reading experience as being difficult due to text being too small, or that eyesight issues presented a barrier. These were addressed in most cases by zooming in on the text, however this came with its own limitations as this constrained the available screen space and further limited the viewing experience. Poor eyesight was not a factor cited by many participants, however participant 17 did raise this as an issue that deterred them from using small screen technology for learning.

> *I didn't think because I'd had a problem with my sight I went and had my eyes tested and then I had started wearing glasses so I've been wearing glasses for about 3 years and previously that's what's deterred me from mobile learning devices because essentially I couldn't see them. (Participant 17, Male, BSc, Level 6).*

Perceived Stigmas.

The previous experiences of using mobile devices in learning contexts was explored to discover how these experiences had shaped learning habits, both with and without mobile devices. The participants described experiences that ranged from more mature participants who did not have access to available technology or connectivity during their formative learning years, to the younger participants who were exposed to more ubiquitous connectivity. Interestingly, the issue of age was raised in this context as a barrier to the use of mobile as the stigma of being a younger person learning tool was raised. This is interesting in the context that the participants were a blend of Generation Y and Millennial generations.

The participants describe a number of occasions where the social uses of mobile technology in prior learning institutes. These chiefly applied to high school in which teaching staff did not allow participants access to their smartphones during school hours. Participant 8 describes a scenario from school experiences that perpetuated into higher education

> *We weren't really allowed them. We won't even allowed them in the corridors at school. Or even it was quite strict, so I suppose then when you're like this it is a bit. (Participant 8, Female, BSc, Level 4).*

Previous threats of phone confiscation or verbal warnings were described by a number of participants who had entered higher education direct from school or sixth form college. Many of these stigmas from school remained when participants entered higher education.

> *I guess at school like, getting told off. Everyone did have the phones out at some point and got their phone taken away. (Participant 2, Female, BSc, Level 5).*

Thus, a perceived stigma was attached to the use of devices that existed within University contexts and while an encouraging participatory approach was applied to some contexts, experiences were also described where these stigmas still held true as some University lecturers voiced similar though less strict rules of conduct. The stigma of being individually or collectively identified therefore created a negative stigma for participants within some learning environments and led to a decision not to use mobile mediated learning within classroom situations. Participant 20 cites an experience which re-enforced the negative stigma and a potential reason why participants may choose not to use this method.

> *There are still lecturers who don't like you using your phone or still lecturers that if they see you using a phone they will stop and wait for you to stop, so the negative impact of using your phone in class is that people are even less likely to use it for education. (Participant 20, Male, BSc, Level 6).*

Previous experiences were described where mobile phones were confiscated if seen in use, hence this may have re-enforced the decision. Strategies to address this were observed and in some cases adopted by participants as the stigma was associated more with mobile phones rather than laptops. Participant 20 commented that many fellow peers would access materials during taught sessions such as lectures using laptops, tablets and smartphones. However, there was an assumption in the opinion of both this participant and others that lecturers would think using a smartphone for this equated to social or recreational use. Participant 5 describes a similar scenario.

> *I don't want the lecturer to think I'm just texting when I might just be seeing what the module name for this or what the module number is. (Participant 5, Male, BSc, Level 6).*

A contrasting opinion was put forward for the use of a laptop in class here as a laptop was associated and equated with a more academic stigma. The net actions of participants would therefore be to refrain from using smartphones for fear of being stigmatised as a non-engaging student.

> *When you see somebody on a computer, or these teachers see them using a computer [in class] they think they're checking this out they are just on a lecture slide. So, it's more of an association that laptop means education and mobile means social. (Participant 20, Male, BSc, Level 6).*

The participant went on to say that the use of such devices could be a useful method for clarifying certain aspects of a lecture or a seminar, however the stigma attached to this may outweigh the benefit.

> *I don't think there's any negatives to using your mobile phone other than the [perceived] stigma attached [by staff]. (Participant 20, Male, BSc, Level 6).*

The use of mobile devices for video capture of lecturing staff raised another perceived stigma, that of politeness. Many situations occur where learners are shown demonstrations but are not sure of the etiquette of capturing this footage. This experience was most noticeable when participants describe the early stages of their programmes and were not sure of the 'rules of engagement' when filming demonstrations. This posed a barrier to the use of mobile devices as learners were often keen to capture such footage for their own skill development but chose not to due to a sense of politeness.

> *People don't tend to get their phones out and video it so I think that's a politeness thing. How would you feel about somebody videoing you doing something like cervical mobilisations or something? (Participant 12, Male, BSc, Level 6).*

Other participants who were 'mature students' felt that this was an activity that was a younger student's strategy and therefore was a barrier to use.

> *I think I'm a bit to old school to get an iPhone out during a lecture or even a seminar. (Participant 12, Male, BSc, Level 6).*

Fear of Being Judged.

Whilst many of the participants in this study cite examples where the use of mobile technology has been a very useful learning tool, the journey towards this has sometimes been a different story. Examples have been cited where participants value the use of learning via social media, collaboration and video due to its interactivity and simple user interfaces. Participants can study at their own pace and in a time that suits them best. The accessibility to 3rd party resources is ubiquitous, allowing these corporate platforms to be accessed without too much difficulty, therefore presenting few barriers. However, the creation of content from a more personal perspective presented more barriers than originally anticipated.

Participant 9 described a common scenario amongst the more mature participants who were less familiar with the ubiquitous use of video capture.

> *I hate performing, I hate it when someone puts a camera on me…it's like aaahh. (Participant 9, Female, BSc, Level 5).*

The fear of being judged emerged from the data as a barrier to mobile mediated learning due to the perceived image that many participants described. This was defended by participants by stating that they were unsure if their opinions or skills were perceived as competent or correct and that often, before committing to a more public post, they wanted to achieve near perfection. Examples of this were described from social media posts, where the perception of their opinion was that it was irrelevant, or that videos posted to YouTube (as required by one modular assessment) would be accessible to the general public or specific professional audience (in reality, these were posted with private URL addresses).

> *I don't think I wouldn't put it on YouTube for the wider public as it were. I think the permanent point being the reason, because I'm not sure myself whether it's actually correct. (Participant 20, Male, BSc, Level 6).*
>
> *if I am mumbling or I might be thinking or pauses of silence well that's alright because they are like that with me as well but if it is to a wider audience I'd like it to be perfect and on the money just because I don't know it is always on the Internet and it can come back to haunt you. (Participant 13, Male, BSc, Level 5).*

The interpreted 'fear' of public judgement was described by a number of participants in varying formats and included dislike of their own voice, acting in ways that were somewhat artificial and appearing to be 'pushy' or rude when engaging in group work. Participant 13 perhaps echoes the feelings of participant 9 but qualifies why. Participant 17 recalls an experience from the early part of the programme where peers were studying anatomy and would use images or video to capture footage of their own personal anatomy learning. In this scenario, participant 17 cites a fear of being perceived to be ‘pushy’.

> *I have never tried that myself [make own audio] and I don't think I'd like to listen to my own voice either but it's I think it could be beneficial. (Participant 13, Male, BSc, Level 5).*
>
> *in that first year when everybody was crowding around the skeletons, I probably didn't push my way in like I should have done because I was the older guy, so I thought I'll go away and read about this. (Participant 17, Male, BSc, Level 6).*

This had more focussed aspects also as the use of social media communication apps such as WhatsApp were often used as information exchange hubs for short questions and answers around generic content such as hand-in dates, assignment guidance, timetables etc. Within these social media sites, large and small study groups exist which either include the entire student cohort, or smaller collaborative groups. The engagement within the groups was described by a number of participants and more frequently, the smaller groups were used, with the larger groups being largely populated by a smaller number of students within the cohort. What seemed to emerge from the data was almost a reluctance to post on a wider scope, and more comfort within a smaller, more well-known peer group.

> *For study, I would definitely use WhatsApp more, because there’s a big physio year group and there's another with about 8 to 10 of us in. So, I'm more likely to message the smaller group for most of my questions. (Participant 22, Female, BSc, Level 5)*
>
> *So, we have a group on WhatsApp with 5 of us from uni and we use that to talk about assignments and exams and things. (Participant 19, Female, BSc, Level 4).*

Distractions.

Whilst the advantages of almost instant communication and accessibility to a range of information sources has many benefits, it comes with drawbacks and distractions. The accessibility of learners to their peers both locally, regionally, nationally and in some cases, internationally presents many opportunities to lose focus and to either consciously or unconsciously become distracted. Experiences of distractions presented some interesting findings as these were often well understood and participants were very self-aware of the ‘temptations’ of mobile devices to provide distraction. Many participants echo the view if participant 23, that smartphones provided the biggest distraction and hence preferred to use a tablet [in addition to other aspects such as screen size] over a smartphone for mobile mediated learning purposes.

> *I would be more partial to using a tablet over a phone I think because, with a phone there's quite a few distractions. I feel that's quite a big barrier for me. (Participant 23, Male, BSc, Level 5).*

Distractions often-involved social communication apps such as text messages, private WhatsApp notices, or push messages from other social media sources such as Twitter, Snap-chat, Instagram, Facebook, Sports apps etc. Due to the small portable nature of mobile phones, these were usually accessible to participants either via visual, audible (tone-based messages), or sensory alerts such as vibration. These create an instant distraction through curiosity, hence strategies such as removing phones from the desktop, placing in adjoining rooms or disabling push messages were adopted to reduce these. Participant 7 describes how they then often become involved in answering peer group chat questions. Prior to receiving the message this participant had been focussed and productive, however the visual alert caused a distraction that led to a break in concentration and unproductive time on their own personal task.

> *I do think ‘Oh, I wish I just left my phone downstairs’, because now I am helping them with their revision which is fine but now, I am not concentrating on what I was concentrating on. (Participant 7, Female, BSc, Level 6).*

Whilst social media apps such as Twitter, were generally viewed as being helpful for finding certain peer reviewed information, it was also recognised that they could be time-consuming and distracting and therefore some participants chose not to engage with Twitter at all. Participant 13 describes this scenario.

> *I just think it [social media] would be too distracting for me or time-consuming. Not that most Physio things would be… I wouldn't invite a load of trolls as they call them online. (Participant 13, Male, BSc, Level 5).*

Participant 4 also had this realisation, however had a different strategy as they felt that short periods of interaction were useful but could lead to distractions. These were not as a result of engaging with content, but more as a tool for procrastination due to 'push messages' from other news feed type apps or communication type apps.

> *I use it more for quick learning rather than having it as my main tool for sitting down and learning because I just think I get distracted really easily with my phone. (Participant 4, Female, BSc, Level 6).*

As a result, many participants cited the use of a laptop or desktop to be a better method for engaging with content over a more sustained period of time, hence strategies to avoid smartphone distraction involved placing them out of sight or turned face down hence participants were unable to see push messages that were sent.

> *They are around me but the phone is probably a distraction when I'm on a laptop. It will be like "oh I am getting bored now and I will send a message to somebody" or "I will just have a look at that". It's never really anything educational and without it is more [?less} of a distraction, a tool for procrastination. (Participant 9, Female, BSc, Level 5).*

Often a cited reason for the avoidance of mobile technology for learning purposes was the barriers and distractions posed by this type of technology. This became a significant finding as many cited valid reasons for the avoidance or non-use of technology. Some of these barriers were hardware or software oriented, however the emergence of financial cost of both the hardware and the data plan to support continued use was noted and often cited as a reason. The small screen size, particularly of smartphones was also often cited as a reason for using alternate methods and strategies. Tablets fared slightly better than smartphones due to their bigger screens, however the poorer file structures offered by tablet operating systems were cited as a barrier to their use. As the participants were generally younger and fit, eyesight issues were seldom reported as a barrier. Other quoted barriers could be linked to the financial outlay as older mobile technology possessed less storage capacity and often participants had reached the storage capacity of their device and were unable to use this further for activities such as video capture. Also connected with older smartphones was the issue of battery life and the associated frustrations that this caused. This was cited by participants as a reason not to use their phones for battery hungry tasks such as video and image capture.

Distractions were commonly experienced by many participants who used mobile devices for educational learning. The use of pop-up notifications was frequently cited as a distraction, as was the audible signals that accompanied many incoming messages through email, and other associated text-based messaging services or social media. Distractions however were not always associated with incoming communications as often participants would take breaks from study and engage with their smartphones. This resulted in significant distractions as social media sites (Facebook, WhatsApp, Snapchat etc. were checked and ultimately this led to far longer study breaks than were originally planned.

Theme 4. Support Tool.

The theme of mobile technologies being used as a support tool emerged early in the data analysis, when it was clear that mobile devices offered participants flexibility and customisation for a number of support tasks. Some of these support mechanisms have been discussed in greater detail in earlier themes, however, it is worth re-visiting the overall support that mobile devices offered rather than specific learning strategies e.g., learning specific clinical skills. On many occasions' participants described experiences where a mobile device acts as some form of support tool, either to access material that aids clarification such as looking up an unfamiliar term during a lecture or seminar presentation or to support learning through feedback and reflective development. This mainly occurred where video was captured, and participants used the material to reflect on and improve clinical skills or in preparation for oral-visual presentations. These codes were grouped into academic skills and organisational development skills categories and then themed. Thus, the theme of support tool includes instances where participants describe experiences of using mobile devices for academic, personal and clinical development purposes. These are presented below both diagrammatically under their framework, the process of charting and arrival at the final theme of Support Tool. They are then described in more detail within the text.

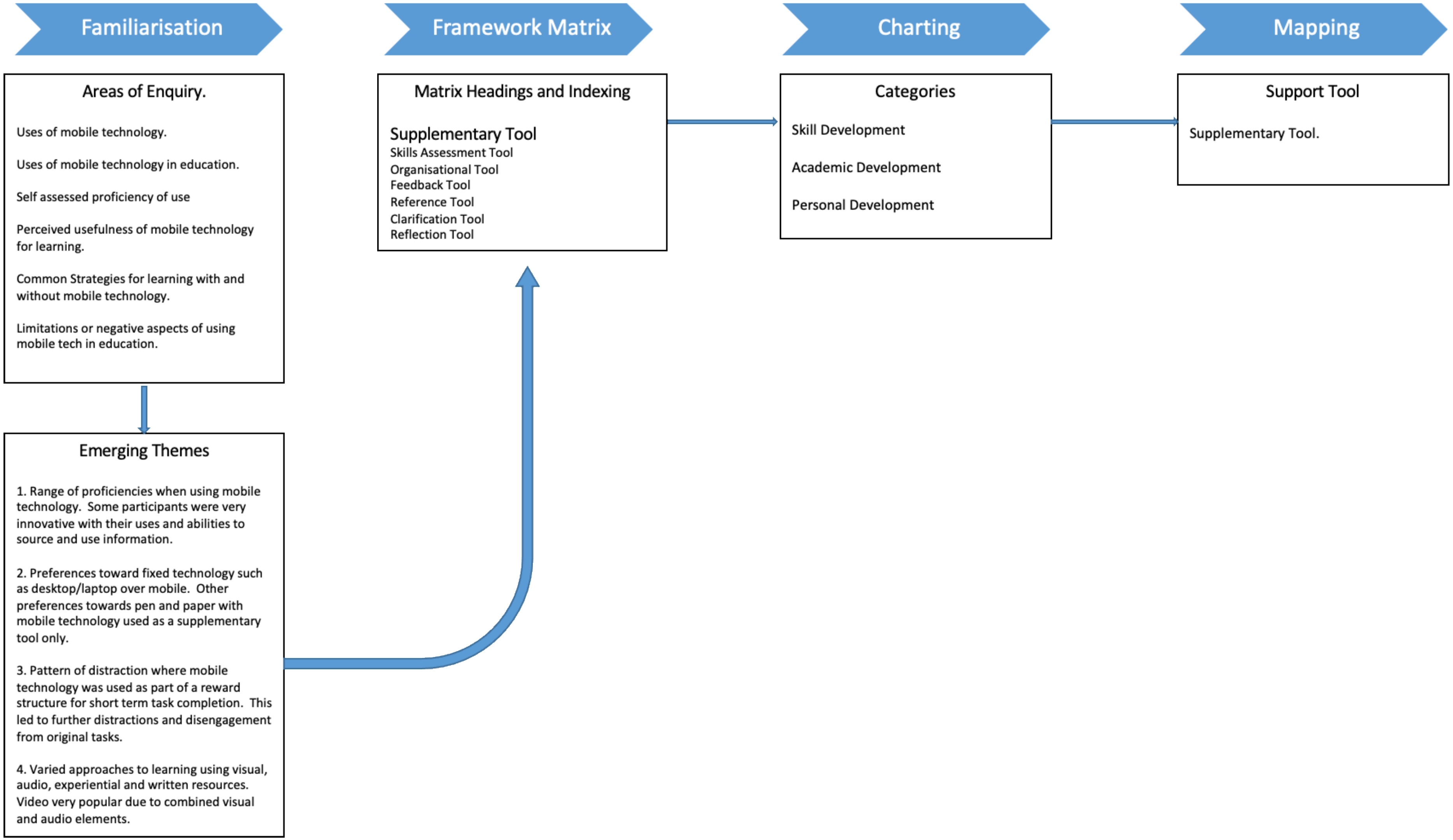


Table 4.33: Development of Support Tool Theme.

Feedback Tool.

The use of mobile devices for the purposes of feedback was multifarious, sometimes involving self-evaluation and reflection, and on other occasions involving peers or members of staff for feedback. The use of social media apps for file sharing and exchanging was used to good effect by many students, who would provide feedback to each other on aspects such as clinical skills proficiency or the quality of content for presentation type seminars or modular assessments. The value of mobile devices over other technologies was possibly linked to the ubiquitous nature of mobile, where peers were more likely to see associated push messages or questions posed through social media and respond, thus giving a more rapid response to feedback requests. Some of the feedback would occur as face-to-face feedback after capturing and reviewing video footage and thus served to develop peer support networks in smaller working groups. Participant 4 worked closely with a peer to record and review footage and provide each other with constructive or supportive comments to enhance skills. Participant 23 outlines how peers practiced, captured footage, reviewed the footage and again, enhanced their skills through peer feedback.

> *There was practice beforehand and then see what we were going to do in the video, so we know if we knew what we were going to do before it we recorded it and then send it off for feedback. (Participant 23, Male, BSc, Level 5).*

> *Me and her share recording each other so then with watch each other so 'you said that wrong' or 'you did that wrong.' (Participant 4, Female, BSc, Level 6).*

The influence of mobile technology for feedback was also described by participants when preparing for assessments driven by oral-visual presentations. This has previously been described in a different context in the learning strategies theme, but also demonstrates the dual use of mobile technology for both content appraisal/rehearsal and self/peer feedback. Mobile therefore offered a simple method of capturing this type of content, facilitated sharing to others and also offered the ability to provide and share feedback that then has a direct influence upon assessment and achievement. This was deemed to be a positive experience for this type of assessment, however there were fewer positive influences regarding skills development feedback from clinical skills perspective. Whilst skill development has been presented in the development of clinical skills theme, the use of feedback was thought to be less valuable when provided for electronic type footage. Electronic feedback was also raised by some participants in the context of social media platforms such as YouTube. The question of loading media resources to platforms such as this was explored, however this was perceived as a potentially negative environment, hence the fear of being judged externally acted as a constraint.

in this module of public health in contemporary physiotherapy where we've been doing a presentation as our exam, in our little groups we record each other presenting our presentation so obviously it helped us time wise. (Participant 6, Male, BSc, Level 5).

> *I don't think I'd want to but I can see it could be useful because if you did share to a wider audience like say openly on the Internet, and you would get people saying well that's wrong or commenting and you know you would learn a lot from other people giving you feedback but I would see a lot of that would be negative feedback and you would get engrossed in arguments and things online. (Participant 13, Male, BSc, Level 5).*

Some participants did not find feedback in this format helpful however and preferred to have feedback offered in a face-to-face environment. The context to this is that academic staff were available to provide feedback to students. Captured footage was forwarded to academic staff through a University based file exchange platform and academic staff were then able to view the footage and provide constructive advice on different aspects of the skills demonstrated in the video.

> *I'd prefer to be giving feedback in person. I don't think a video was as helpful as such because... especially a manual technique it needs somebody there to... for example your hand*

holds you can't have somebody replying virtually on your feedback saying maybe your hand could move down. It doesn't work like that. (Participant 23, Male, BSc, Level 5).

Reference and Clarification Tool.

A very commonly described experience was the use of a mobile device (most commonly, a Smartphone) to clarify concepts that were presented during both informal self-directed learning and formal taught sessions. The lecture was the most commonly described formal taught session, where participants would describe experiences where they accessed a mobile device to clarify or define a word, concept or process. The definition then clarified the context of the content e.g., lecture slide. This then allowed the participant to understand meaning and continue. Participant 6 and 20 both describe occasions where a smartphone was used in this way, while participant 6 also used their smartphone to access a research study that had been referenced within the lecture.

During lectures if there is something which I don't understand I can only obviously use my phone just quickly to research and see what….what the word was said what the study was and just pick up on it during the lecture. (Participant 6, Male, BSc, Level 5*).*

In terms of educational, when it comes to the phone I use it occasionally during lectures, just purely because I don't understand what the lecturer says or a particular word that doesn't make sense and they skim over it, I'll quickly Google it and see what the definition is and get a better understanding. (Participant 20, Male, BSc, Level 6)

This was thought to be useful where concepts that were unfamiliar had been introduced within a lecture and the participant then used their smartphone to access an image of the content in question. Participant 6 cites an example where they were unfamiliar with the 'Health Belief Model' which was introduced as part of a Public Health module. The participant accessed an image together with some text-based content around this model and was then able to re-engage with the lecture content.

for example, if our lecturer has gone over the health belief model for example, I would have just said okay what is it? XXX hasn't explained it, or I haven't understood it and I just research it quickly on Google to see what it is. (Participant 6, Male BSc Level 5).

Smartphones were used commonly alongside other technologies e.g., a laptop and often formed a symbiotic relationship as the participant would use a laptop for note taking or to access slides via Blackboard and the mobile phone for quick access to unfamiliar terms using services such as Google to perform the search. Participants were able to access content such as the example of the 'Health Belief Model' above, however, many chose to use a smartphone for this task rather than to use their laptop. Participant 4 indicated that this was a common strategy for their age group and that many students of a similar age would use it in this way. Participant 22 once again raises the issue of stigmas (described in theme 3) when using a smartphone, however in this situation, a smartphone was used in combination rather than isolation.

> *if I'm on the computer and I see an article or something, but I don't understand it, I'll go on my phone [to clarify] because it's quicker to search rather than open up a new tab and do it that way. (Participant 4, Female, BSc, Level 6).*
>
> *I think most people my age use it in a similar way so we use it for a quick searches and quick things. (Participant 4, Female, BSc, Level 6).*
>
> *I don't know if you're allowed to do this either but sometimes it's useful to look things up. (Participant 22, Female, BSc, Level 5).*

Other examples of using mobile devices for clarification involve using a smartphone or tablet alongside a textbook. Multiple methods were used such as the use of a book and a downloadable mobile app to give more context to a 2-dimensional picture. The use of 3D visualisation offered by anatomy applications allowed a greater appreciation for understanding as they offer an interactive 3-dimensional view of structures in a way that 2-dimensional images could not.

> *I am just thinking of MSK, I use the app and then my [Anatomy] Trail guide at the same time. Just kind of, I don't know how it helped me, but it gave two different views of the same thing. (Participant 10, Female, BSc, Level 5).*

On other occasions, mobile devices were used in combination with Google to simply clarify a concept where two contrasting or contradictory views were encountered.

if I didn't understand what the book said or if 2 books contradicted each other I would obviously use my phone go on to it and search on google. (Participant 6, Male, BSc, Level 5).

A lesser used strategy for clarification was offered by a participant as the mobile device gave a sense of translation to a set of notes that had been taken during a skills demonstration. The notes perhaps contrasted with the learning approach of the participant; however, the use of video capture offered a means of clarification to the participant. This perhaps partly explains why video capture was used as a more common approach to learning clinical skills than note taking, as note taking can be correct, but the processing of this information is not instinctive.

> *If I have handwritten step-by-step method then a lot of the time they'll make no sense to me so looking at the video is quite good for me to actually see what is happening or to have corrections of what I've meant to be doing and what is supposed to be done. (Participant 8, Female, BSc, Level 4).*

Supplementary Tool.

The general trend from many participants was that whilst mobile technology offers some valuable strategies that feed directly into learning in key areas of skill development, it would not be a replacement for other methods of learning and is simply another tool used to improve knowledge and enhance understanding. Participant experiences describe examples of this from both academic and clinical perspectives, where, at key times of an academic calendar, mobile technologies offer an additional approach to other forms of study. Participants describe that mobile technology, whilst useful for certain types of learning, was not used in isolation and was used as part of a wider learning approach.

> *So, whilst it might be able to support it [learning] and there's different ways of doing it I don't know if I'll ever be fully comfortable with being completely tech and no paper. (Participant 15, Female, BSc, Level 6).*

> *I use it effectively when we've got a high workload so I wouldn't use that time if we didn't desperately need something doing, so if it's a time where exams are coming up or if there's a lecture immediately after then yes, I would use it. (Participant 16, Male, BSc, Level 5)*

> *I would go into my room and I would use my desk and just sit there. But the obviously my phone and my tablet are just an adjunct to that. (Participant 7, Female, BSc, Level 6).*

> *I would say is pretty much supplemental so if I've got any proper work to do, we'll go on the laptop or the computer. (Participant 12, Male, BSc, Level 6).*

> *the night before I could just go on my phone and re-scroll through the booklet to get a bit of insight on the healing processes and things like that, so I used it as a last-minute tool rather than like strong revision. (Participant 4, Female, BSc, Level 6).*

Part of the rationale for the use as a supplementary tool rather than a primary learning strategy was described by the limitations experienced when using mobile devices. The experiences that were described, indicated that while mobile devices offer advantages in terms of convenient accessibility to documents and learning resources, this is then countered by the limitations of inputting capability where the creation of learning resources or revision documents.

> *For academic papers, you can as easily go on your phone as you can your computer and I found that being able to use that was quite useful when you can't really take the laptop out and go from there. (Participant 20, Male, BSc, Level 6).*

on my phone I'm kind of limited to literally just reading up brief notes and if I was to type anything, I definitely wouldn't do it on my phone I'd do it on my laptop. (Participant 16, Male, BSc, Level 5).

in practical's, I can remember it even if there's a teacher in the room is just easy to Google something and less work for the teachers as well. (Participant 12, Male, BSc, Level 6).

I definitely advise them [future learners], to have phones and things but you just use them responsibly. (Participant 7, Female, BSc, Level 6).

if you have a conversation about something that not any of you have got a true experience of, or knowledge of for the kind of present back to the group on something that you really don't know anything about, it is really helpful to have your phone there or your tablet or whatever it is you've got on you to kind of pick up and say actually if we want to make this point let's just have a look at something else to back it up with things. (Participant 15, Female, BSc, Level 6).

Reflection Tool.

The use of reflection is a skill that is encouraged from semester 1 of year 1 in the Physiotherapy programmes. Students are introduced to models of reflection and encouraged to engage with reflection in a number of ways, from open dialogue, to written reflections following sessions. The use of mobile devices as a tool therefore was an innovative approach and helped to capture reflection in a different context. The availability of practical skills to access from previously captured video footage, enabled participants to reflect from an entirely different perspective. Usually, participants would reflect on skills or events using only their recollections from the selected learning event e.g., seminar, practical etc. However, the capture of skills allowed a more reliable and potentially more objective source than was previously possible. Participant cited the ability to stop, rewind and review as an important aspect in motor skill acquisition, but much of this development was also a result of reflecting on communication skills.

I'll get somebody else in the group to record me doing a particular intervention and I can reflect upon it and use it to see how you come across. (Participant 17, Male, BSc, Level 6).

Whilst this also links to an earlier theme around clinical skill development, these participant experiences perhaps offer a slightly different perspective around the use of reflection and the capability of mobile technology to offer this. Whilst captured video footage offered the opportunity to assess self-competency for short term development, this was developed further by Participant 16, who looked at a longer-term improvement and how the use of video capture supported this. They describe how reflecting over a longer time frame helped them to reflect on their early skill development and to then reflect on how the skill had subsequently developed and improved.

> *To look at them now... in that time, skills could have developed, and I could see what I was doing then and how I have improved on that. So, it would be good as a tool for reflection, I think. (Participant 16, Male, BSc, Level 5).*

Organisational Tool.

The transition of organising events and timetables from paper to electronic format was described by several participants who stated the use of the University timetabling app or use of Microsoft Outlook diary had assisted their organisational development. The access to diary events and to timetables via mobile devices was often due to speed and convenience of access due to the ubiquitous availability of their mobile (phone) device. Many participants also used mobile devices to access email accounts (both University and personal). These were accessed either by a specific 'app' such as 'Gmail', 'Yahoo' etc. or through the specific Mail folder offered by the operating system of the individual mobile devices. Participants found that this gave access to information more readily and hence the mobile device functioned as an organisational tool. Varying levels of digital literacy facilitated the degree of organisation, as some participants were able to 'push' university email messages to their own personal accounts and hence needed access to only one (personal) email account. Other experiences describe the use of email as a method of storing and accessing resources, where useful documents would be sent to their own personal email accounts and 'tagged' with an appropriate label. These 'tags' were then used as a search term within their email messages to allow ease of access to these resources.

> *I think what's helped me this year is having like emails, different email accounts on my phone. (Participant 21, Male, BSc, Level 6).*
>
> *I prefer to use my laptop but if you run out of time then I use my phone, but just kind of for organization I guess. (Participant 2 Female, BSc, Level 5).*
>
> *I find it [using Dropbox via tablet] much easier rather than coming to shuffle through what can often be disorganized notes it keeps it in a very neat, structured format to be able to go back and add your own material. (Participant 1, Male, BSc, Level 6).*
>
> *I tend to use it as my diary as well and sometimes for my notes on my phone. I write down I have a meeting rather than having a diary at my side. (Participant 4, Female BSc Level 6).*

The qualitative study aimed to provide a better understanding of how and in what contexts participants use mobile technology for educational learning. The interviews provided rich sources of qualitative data from a varied sample of participants who had been selected purposively to give a balanced view of usage. Whilst the definition of Rogers (2010) includes five categories of adoption (innovators, early adopters, early majority, late majority and laggards), the aim of this study was not to apply a strict criterion, but to recruit interview participants based on the cluster analysis of their survey questionnaire responses. The selected participants did not aim to correlate with the categories proposed by Rogers (2010), but distinctive patterns in the data could be observed. Some of these relate to the perceived level of digital literacy, however other patterns (themes) showed commonalities demonstrated by many regardless of which cluster the questionnaire results had been categorised to.

The theme of smartphones and tablets acting as support tools became a significant data finding early in the data analysis. Many participants gave examples of how these devices were used in a variety of support settings. These ranged from being organisational tools that helped in planning the working week where timetables could be accessed through the University App and electronic diaries through the Outlook calendar, where additional organisational tasks could be recorded. Mobile technologies were also used for clarification purposes, particularly in lecture environments, where lecture slides could be accessed and followed electronically, or unfamiliar terms could be accessed and interpreted through the internet, the mobile device, effectively being used as a mobile dictionary.

Chapter 5. Discussion

Discussion of Quantitative Findings

A strength of this research is the identification of participants into clusters or groups who show differences from the overall group descriptives. The hierarchical cluster analysis produced three distinct groups who demonstrate differences in both positive and negative opinions/responses. This highlighted that a range of opinions within the overall group exist and there were significant differences of opinion between the three clusters. The advantage of this is that it reduces researcher bias when selecting a purposive sample for interviews and allows a more objective selection process for interview participants as it identified both potential promoters and negators of mobile mediated learning.

Cluster one responses were associated with a positive opinion with respect to use of their mobile device for learning purposes. This group demonstrated a 79% positive response in comparison to cluster two (64% positive) and cluster three (21% positive). This clearly demonstrates a positive relationship regarding their opinion of mobile mediated learning through technology use in education. The evidence of their responses across the constructs show agreement in all three constructs. Cluster two demonstrate a positive response, however, demonstrated more neutral opinions regarding uses concerned with using mobile technology to assess performance and skills. There was a disagreement that mobile technology was useful for creating documents, however the group showed agreement across the three constructs that mobile mediated learning was useful. Table 5.1 shows the distribution of each cluster to the opinion statements showing the percentage agreement and disagreement.

Percentage Agreement and disagreement for 14 questions within separate clusters	Cluster 1	Cluster 2	Cluster 3
	HIGH AFFINITY	MEDIUM TO HIGH AFFINITY	LOW AFFINITY
Agree	11 (79%)	9 (64%)	3 (21%)
Neutral	2 (14%)	4 (29%)	5 (36%)
Disagree	1 (7%)	1 (7%)	6 (43%)
Total	14 Questions	14 Questions	14 Questions

Table 5.1. Summary of Agreement and Disagreement by Cluster.

The results demonstrate that clusters one and two held similar opinions regarding the usefulness of mobile mediated learning and had a high or medium to high affinity with this type of learning. The use of mobile mediated learning was therefore much more connected to the three constructs shown in chapter 3 (access, create, development). Diagram 5.1 depicts the connectedness of these constructs with clusters 1 and 2, and how they are interconnected with the mobile device, however it is acknowledged that these were not tested for their inter-relatedness.

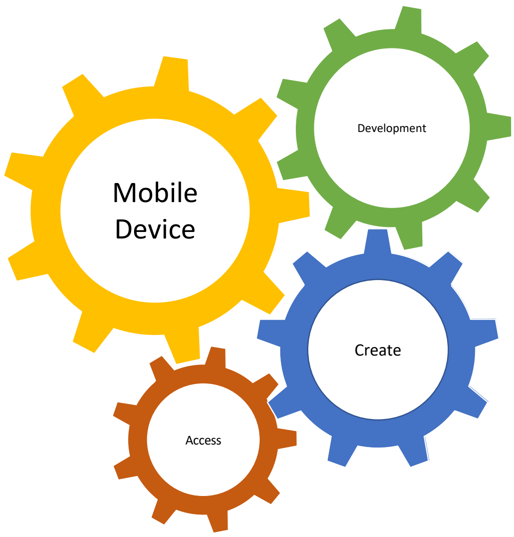


Diagram 5.1 Showing Interconnected Nature of Constructs in Clusters One and Two.

Cluster three shows a clear agreement with only three statements, a neutral response to five statements and a disagreement with six statements. This group agreed that mobile technology was useful to access resources such as YouTube, for linking information together and that they agreed they felt confident when using their devices. The reasons for this may possibly be a preference towards more traditional and familiar learning methods such as use of textbook and text-based materials or potentially that they did not have the same access to mobile mediated learning due to owning fewer devices (median=1 compared to median=2 for other groups). Sorgo et al (2017) cites the ownership of some mobile devices (tablets) to a negative predictor of information literacy, and whilst this was not measured in this study, may suggest that smartphone and tablet use facilitate an easier method of accessing information than using a laptop or desktop computer. Certainly, the use of mobile mediated learning for researching, accessing, and exploring is less well accepted amongst this group. Bhatt and MacKenzie (2019) report similar findings as cases differ substantially in how they search for and interpret information and link this to a degree of information literacy. Similarly, the use of mlearning and mobile technology for creative methods that may be used for development and storage of personal resources is less well accepted in this group. This may again relate to respondents lacking the skills to develop these (document based) resources or manage storage capabilities, or simply a preference for other forms of learning such as group working or traditional paper-based methods of storage. Ladyshewsky (2008) comments that students like to learn from each other in simple, non-threatening environments which may suggest that practicing and discussing skills and theoretical content is preferable rather than through mobile mediated methods.

The relative size of the screen, equally, may be a constraint for cluster three who demonstrated the lowest ownership of larger screen tablets (32%) in comparison to cluster one (65%) and cluster two (56%), which lends weight to the argument by Sorgo et al (2017) that this group may have well developed information literacy skills hence use laptop or desktop computers preferentially. Mobile phone ownership in this cluster was 100% which is comparable with the other clusters.

Opinions indicated a less connected approach to learning using mobile technology in cluster 3 and whilst there was some agreement that access to internet and YouTube was useful, and that some aspects were useful for the creation of resources e.g., video capture, there was little appetite for development of skills with mobile technology. Diagram 5.2 shows a partial disconnect between the constructs in line with the results of the inferential statistics. It demonstrates that this group have a low affinity with mobile mediated learning and that the 'create' construct is the most closely aligned with the use of mobile, while the other constructs of access show a partial separation and development shows a distinct separation.

Again, it is acknowledged that these constructs were not tested for their inter-relatedness and that the diagram represents a pictorial rather than scientific relationship.

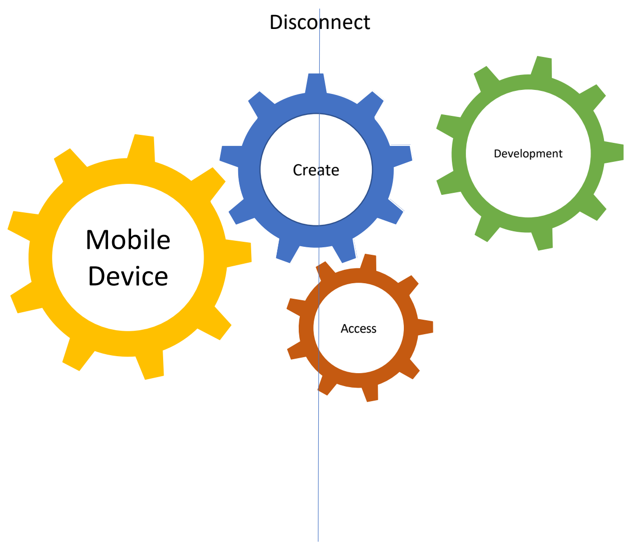


Diagram 5.2 Showing Disconnect of Constructs in Clusters Three.

The effect of age on opinions must also be considered in relation to the results. The frequency of participants in the 26-45 age group is much higher in cluster one (more than half of all 26-45 yr. old respondents) and indeed, this cluster shows only 4% in the 18-20 age group. This is perhaps surprising given that the 'millennial learners' described by Howe and Strauss, (2000) would be expected to engage more with contemporary technology. This age group (18-20) however forms the majority of cluster two, comprising a total of 71% in the group. Where this age group disproportion may show its greatest effect is the use of mobile technologies for storage and as a primary source of learning. Possibly this relates to the informal nature of learning in social situations being recorded and stored, hence the dialogue between this younger age group is valued and effectively becomes part of the learning process (Park, 2011). The most frequent age group in cluster three is the 21-25 age group (45% of cluster), however it is interesting to note that 39% of this cluster are also made up of the 18-20 age category. Only 16% of cluster three (low affinity) therefore is formed by the 26-45 age group. This contrasts with Prensky (2001), and Howe and Strauss (2000), and more contemporary research (Schwartz et al. 2018, Loganathan and Hashim 2020) who state that younger generations of learners e.g., millennials, are much more accustomed to using technology easily and at ease. The results of the survey questionnaire are suggestive that the more mature students from an older age demographic are more aligned with mobile mediated learning. This may be simply that younger participants do not use their smartphones and tablets for learning, but for other activities such as communication and leisure type activities. However, what is clear is that the mature students are using mobile mediated learning more frequently and are supporters of this approach to learning. Cluster one, who demonstrate more 26-45 yr. old participants, showed a preference towards a visual learning resource and a strong (more than half) preference toward practical type learning. This may include both face to face teaching and practice, but also engagement with video type resources to improve clinical skills. This is reflected by Cluster two who also showed these preferences, but less strongly (less than half indicated a kinaesthetic preference). This could indicate a preference to 'watching' demonstrations either live or via video platforms rather than via hands-on practice. It is therefore possible that the higher level of time spent observing via mobile devices has contributed to a higher perceived level of confidence using mobile devices due to the deliberate practice element as described by Ericsson, (2008).

It may also represent confidence in familiarity as practical type learning activities are largely unfamiliar to students entering, HE institutions for the first time. Cluster three who feature fewer mature participants, showed an equal preference toward both visual learning resource and practical learning, but also demonstrated the highest preference for both kinaesthetic and read/write learning and also demonstrate a co-preference for visual and kinaesthetic learning; hence it is also possible that the group value practice as much as watching practice online.

In conclusion, the findings of the quantitative study discovered that there were some key differences in opinions regarding the influence of mobile technology for learning. The sample population demonstrated three different groups or clusters, who demonstrated differing opinions across three constructs. Two groups (1 and 2) showed positive opinions regarding the use of mobile technology to influence learning and showed agreement across the constructs of access, creation and development. A third group (cluster 3) demonstrated some agreement that access to resources mediated by mobile was useful, however, overall, there was general disagreement that mobile influenced learning positively and their opinions differed significantly (significance range p=0.00 to p=0.021) from the other groups. The differences between groups have helped inform the qualitative study and present an opportunity to explore these opinions in greater depth. The subsequent study recruited 23 participants for interview from each of the three groups (Cluster 1, n=8, Cluster 2, n=8, Cluster 3, n=7) with the aim of developing a balanced understanding of why participants hold these opinions. The statistics used (hierarchical cluster analysis) have helped identify and recruit a balance of participants from the groups who hold different opinions. They have additionally ensured through discriminant function analysis that these are independent groups and thus have provided a greater degree of objectivity and greater transparency in the selection of participants to mitigate against the reflexivity and unconscious biases of the researcher.

Discussion of Qualitative Findings

The themes that have emerged from the data suggest that mobile mediated learning has an important role to play in physiotherapy pre-registration learning in this group of participants. There was variable engagement with technology of this type, and it has been highlighted that differing competency in information literacy and digital literacy seem to influence the degree and extent of use. Whilst different degrees of engagement exist, these do not represent a non-acceptance of technology, merely that participants had differing levels of preference towards mobile or other technology. As Sorgo, et al. (2017) has reported, it may not simply be that those using mobile mediated technology have more digital literacy, but quite the contrary and those who engage with it, do so as it represents and easy and convenient approach with a user-friendly interface that permits more convenient options for learning through technology.

The key findings from the qualitative analysis firstly suggest that mobile mediated learning has a significant influence to play in the development of clinical skills. This occurs chiefly using video capture and consumption. Videos are consumed using both university systems such as Blackboard or through social media such as YouTube, Facebook, Instagram, Twitter and more latterly, Snapchat. These are accessed via smartphones or tablets due to the ease and convenience of access. Self-captured videos of skills rehearsals using personal smartphones are also a key strategy for the development of clinical skills. These usually progress from consumption of videos from the platforms mentioned above.

The findings also suggest that mobile mediated learning represents an expeditious approach due to its speed and convenience of access and offers opportunities to engage in collaborative learning through its connectability. These occur either in smaller communities of practice where specific skills are practiced, or larger landscapes of practice as described by Farnsworth, Kleanthous and Wenger-Trayner, (2016). It requires less literacy to access resources using mobile but does require digital skills and awareness to overcome some of the barriers to use. These can include issues of incompatibility, small screen size, storage limitations, limitations inputting text and speed of connection. Some barriers may remain insurmountable due to the limitations of the hardware or data plans; hence this may restrict or limit acceptance. Lastly, mobile mediated learning acts as a support tool for learning rather than a primary method. It facilitates reflection and development through the ability to review performance and can be used as a quick reference tool to clarify understanding in differing learning environments.

Where this study varies from many other studies that have examined technology acceptance across varied contexts, is that the participants recruited, were able to self-select their technology. Many previous studies that have investigated this, often consider technology acceptance based on technology introduction at organisational level rather than at a personal level and utilise measurement questionnaires such as TAM or UTAUT. The aim of this study was to explore influences of acceptance and thus, influences of technology when participants were free to select technologies of their own choice and develop their own learning resources, rather than those solely provided by an organisation. The rules of technology acceptance however, still appeared to be observed, as participants in this study describe experiences where easy to use and useful applications dictated a higher level of personal engagement. The easier to use, the higher the use of the technology e.g., video capture and consumption.

The variable engagement, points to a personalised approach to the use of mobile technology that resonates with the theoretical framework of Kearney, et al. (2012) and the constructs within this. The use of video is explored in more detail below but represents an authentic approach to the acquisition, particularly of practical skills, that physiotherapy students will use in real-life situations. More specifically, this represents task authenticity, where participants often describe how capture, sharing of files and discussions took place around this. These discussions occurred in several ways, both online, as seen with the engagements with WhatsApp, Facebook, and Twitter followers, or in face-to-face discussion with peers resulting from mobile mediation. The video capture of both instructor demonstrations to address epistemic authority, and self-captured skills for reflection, analysis, and evaluation, aim to replicate techniques that would be used in clinical practice and therefore represent a degree of process authenticity. These serve as viable discussion points for participants and facilitate engagement of conversations in a social constructivist manner. The 'collaboration' and 'authenticity' constructs and related sub-constructs therefore serve as an implicit automated response for participants using mobile technology and perhaps demonstrate how participants within the study are exploiting mobile technology in a pedagogically sound manner.

One is reminded of the Burden and Kearney, (2017) study that reported weaker perceptions of collaborative sharing and online conversation associated with the personal construct of the framework. This may suggest that the personal construct is a key participant construct and that learner choice, autonomy, pacing and environment to name but some, are the drivers behind collaboration. The ability to reflect and learn at their own pace at a time and place of choosing using learning strategies and tools that are familiar allow participants to develop understanding within their potential development in keeping with Vygotsky's (1978) zone of proximal learning. The suggestion here is that development is still guided through more capable peers (Vygotsky 1978) but may not solely occur through direct academic staff or fellow peers. Conversely, for physiotherapy educators, authentic learning opportunities may be sufficient to initiate successful mediated mobile learning, by providing appropriate settings and contexts, combined with relevant tasks e.g., via case-studies (often framed around assessment).

Skills in digital literacy, and in particular, social media engagement also appear to have an influence in the collaborative sense through the ability to access, and in some cases create resources. The blend of personalised learner technology choice, and ease of access to social media through mobile technology allow convenient file/link sharing of online and personal content that can be the basis for understanding theory of authentic skills tasks and peer discussion.

The influence of mobile technology in this group of pe-registration participants has been found to be a useful supplementary tool for learning whilst demonstrating variability in usage. The most frequently cited and unquestionably, the greatest use for mobile technology in learning contexts was the use of video footage. This was in both a consumerist and creative manner and was a finding that was independent of the level of digital literacy. The influence of video-based learning can be contextualised by the prediction that 82% of all internet traffic in 2021 will be video streaming (CISCO, 2016). The wide availability of video platforms and ability for users to capture their own video content quickly and easily, combined with the ability to convey tacit and difficult to explain knowledge make this a very attractive strategy (Oparaocha, et al. 2014). The use of video in the form of digital story telling is also linked to the increased use of reflection as a learning tool as reported by Petrucco, (2015) who states that experience itself does not lead to an improved performance, unless reflection takes place. It may then follow, that the use of reflection upon video techniques, both self-captured and via third party social media links, facilitated a deeper understanding of material through reflection and open dialogue within micro cultures that existed within the cohorts.

Whilst the use of digital story telling (LeBlanc, 2017), was not an explicit experience and narration of the self-created videos was not a feature that was quoted by participants, certain features of digital story telling did emerge, but, as collaborative learning experiences, like a social constructivist approach to learning with a digital learning 'trigger'. This is to say that they promote discussion and foster construction of meaning, understanding and reflection through interaction with video source material. Many participants describe the use of video source material as a basis for dialogue with peers and thus a useful supplementary learning tool.

Video footage also has the advantage of allowing participants to concentrate on skill demonstrations without the need for note taking. Marim and Sturm, (2020) comment on how note taking in lecture-based environments allows the invisible knowledge that is being imparted to essentially become visible, hence video offers a different approach to the visibility of knowledge. Rather than this being visible in written form, it is visible in moving picture format, effectively offering a mobile technological option rather than a traditional pen and paper approach. The addition of written notes from video use can add a further layer of visibility if desired.

Whilst mobile technology was an option, it was not a unanimous approach as some participants still valued note taking as a tool for practical skill acquisition. A collective approach, however, where sharing of staff video demonstrations occurred through WhatsApp or email, allowed participants who favoured note taking to continue this practice without fear of missing information. Both McAllister (2014) and Weeks and Horan (2013) demonstrate effective use of instructor video for both improvements in quantitative assessment scores and acceptance through high satisfaction scores. Assessment anxiety reduction was shown to be reduced and better clinical preparation were both features of these studies.   Both show that video capture is valued in clinical skills preparation by students and mimicry around skills, both demonstrated by academics and by themselves develops confidence through the epistemic authority provided by the skills demonstrations. Thus, mobile technology as a learning influence can be both individual and collaborative. What is important is that the learner establishes their own 'authority' over the subject content and as argued by Friesen, (2014), develops an ability to partake in scholarly conversations.

Video footage classically 'ticks the boxes' of traditional technology acceptance models as it is easy to use and is perceived as being very useful in the development of practical and presentation skills. Cann, (2015) comments that it is also a perfect open educational resource that has universal cross-platform availability both for personal video capture and through commercial platforms such as YouTube. For this reason, all participants used video footage following some initial reservations around self-image (particularly the sound of their own voice) and fear of judgement by others. The convenience of capturing footage, combined with the ability to share footage quickly and collaboratively across platforms, made this a universal strategy. The level of literacy was usually only relevant where large files needed to be shared or transferred and required other methods other than via social media (WhatsApp). Apple's airdrop facility also allows transfer of large files, however no participants referred to sharing of video via this method.

The use of video also encouraged a repetitive approach to learning where the flexibility of anytime, anywhere access to content allowed a watch, pause, practice approach particularly around key stages of skill acquisition such as early skill development and refinement when approaching examination periods. The ability to self-capture techniques then allowed further modifications and refinements of techniques thereby encouraging a collaborative approach to learning and further establishing personal learning cultures and small group working. Jones, Dean and Hui-Chan (2010) report that smaller group working in online communities allows more opportunity to interact, hence small working groups such as those that develop through face-to-face contact are perhaps reinforced through social media apps such as WhatsApp and allow for a more reflective and paced discussion of skills and theoretical content that can facilitate cognitive understanding around the rationale for a skill. These smaller peer learning groups help to facilitate skills through video capture, small group working and reflection to grow and enhance theoretical understanding.

Fernandez-Lao et al (2016) and Roe et al. (2019) both demonstrate a flipped classroom approach to teaching which encourages learners to develop learner autonomy and encourage freedom to explore the available staff resources. The rise of the flipped classroom has perhaps encouraged student learners to develop their own self-created resources far more, both to maintain interest and for perceived improved quantitative performance in specific contexts and specialist areas of practice. Both Fernandez-Lao et al (2016) and Roe et al. (2019) demonstrate improvements in engagement this respect but did not demonstrate significant differences in marks although the study designs are somewhat flawed.

Alexander reported using similar resources to those mentioned above but reported a significant improvement in module marks (67% to 75%) in an exercise medicine module. The high satisfaction with provided resources and comments around improved engagement and trust in the content, suggest that learners are happy to develop their own resources and hence professional skills with greater freedom. Chapter 4 reports several participants who feel more re-assured when viewing video-based content made available by academic staff much more than that available on social media platforms. This therefore provides reassurance that the autonomy to capture their own skills can be related to what they see as the 'gold standard'.

The ability to watch and re-watch this is reported elsewhere in the literature. Hurst (2016). Coulson and Frawley (2017), both report the use of vodcasts to develop clinical skills and how these may encourage repetition and refinement of skills (Hurst 2016), visualisation and mimicry (Coulson and Frawley (2017). This is also evident in chapter 4 through cited experiences of video capture for skills in manual handling techniques, manual therapy and anatomical precision.

Whilst these studies represent a wider range of resources and feature both text and multimedia content, it is arguably the video content that is the most significant resource for improvement.

Weeks and Horan (2013) showed a significant improvement in VIVA scores with the addition of clinical case videos prior to a modular assessment, whilst McAllister (2014) also showed that video is extremely valued through the sizeable number of student viewings of available video. This is perhaps a significant finding as participants would be aware of the number of previous viewings that these videos achieved as it was available through a private URL through YouTube. Qualitative data from the results chapter of this thesis indicate that participants do assess the informatics of videos e.g., number of views, prior to selecting resources from YouTube, hence the availability of this indicates the value of such resources.

These findings, demonstrate that several learning theories are embraced with the use of videography. The learning of skills and facts through direct experience at an individual level has its roots in a behaviourist approach where skills can be absorbed. The use of videography can be seen as a contributary component here, but the implementation of practice and repetition arguably, gives structure in a more cognitivist approach, however this is still within an individualistic approach. When these individual approaches expand to adopt group approaches within a micro cultural level, this is classic social constructivism and the use of videography facilitates discussion around techniques and case-study management from pre-set scenarios provided through specific skills modules. The social constructivist approach therefore helps facilitate understanding prior to any self-capture of skills.

The connectivist model is an interesting interpretation as this may be considered at two levels. Firstly, connectivism at its heart is experienced virtually (Siemens, 2006, Duke et al. 2013) and hence the use of social media and the internet play a major role. These platforms offer the ability for users to connect globally with content, material and users and hence facilitate virtual environments where global or national perspectives may be offered in a way that was not possible before these digital platforms existed. The participants within this study who showed higher levels of literacy were the predominant users of social media and the users most likely to engage in online participation. This tended to be users within cluster one, who demonstrated higher mlearning usefulness scores, were slightly older than the other clusters and had a predominantly degree based academic background. Alrashedi, (2015) states that the two biggest contributors that impact most strongly on mobile learning implementation were perceived increase in productivity and an interest in using mobile learning for future use. These combined findings may point to an efficiency-based approach to learning where participants are learning how to learn via a wide network of people rather than a narrow focused and limited perspective. Previous study and experiences of learning may have fostered well developed habits but the ability to remain 'current' could explain the interest in social media through the ability to 'subscribe' to information via 'following' certain users. Thus, rather than searching for information, this is 'delivered' through a news feed allowing these participants an autonomous learning choice through mobile technology.

The use for social media (more specifically, Facebook and Twitter) as a learning strategy was seen to be strongest within cluster one. Recent data suggests that there is a generational behaviour difference within Twitter amongst the wider population with most Generation Z (people born between 1995 and 2015) preferring to use YouTube, Snapchat, and Instagram as the social media tools of choice (Young, 2018), whereas millennials (people born between 1980 and 1994) are more likely to be Tweeting or Facebooking. This data is however, from the general population unlike the findings of Blank, (2017) who selected a more specific population and predicted Twitter users to be aged 18-24 with 18% in Higher Education. The data does however provoke thought, as this study demonstrates the majority of cluster one participants to be Millennials and from Generation X (5+2). The remaining participant was a borderline Gen Z/Millennial, whereas cluster two participants were almost exclusive Gen Z participants (7). These findings showing preferential use of Twitter by Millennials concur with the qualitative findings of this study and represent differing influences upon learning through social media.

Chapter 4 cites many participants who adopted a speedy, quick, and convenience-based approach, and adopted a more 'delivered' social media. The use of Snapchat and Instagram were not cited commonly by participants as a learning tool; however, YouTube was cited frequently. This contrasted with the more pro-active connectivist approach adopted by the digitally curious participants of cluster one who actively use Twitter and Facebook and engage in the sharing of content. Depala and Greene (2016) comment on the significant role that social media plays in physiotherapy practice and physiotherapy teaching. This study is supportive of such technologies and comments how a knowledge of student use social media may assist university lecturers to guide students on correct usage. Many universities have established Twitter feeds e.g., @UoLPhysio has 1000+ followers at the time of writing. Depala and Greene, (2016) comment that students expect technologies such as Twitter to become a part of their learning and that the quality of the accounts will be an important factor. Input from both the Chartered Society of Physiotherapy (CSP) and World Confederation for Physical Therapy (WCPT) to these 'feeds' perhaps provide some assurance that national and international bodies are aware that reliable resources should prioritised to maintain standards.

The use of social media perhaps also relates the changing authority and role of the lecturer. Due to the ability to access and retrieve large volumes of information online, the authority of the lecturer has become diluted and subsumed by the authority of the text. Prior to the digital revolution, lectures and seminars were about transmission of knowledge that was unavailable in the contexts seen today (Marim and Sturm, 2020), hence the authority of the lecturer was less challenged. Participants who had previously completed degrees also commented how the internet had changed learning in comparison their initial degree where access to library services and weekend, electronic or remote access was much more restricted. Modern learners now have access to billions of Tweets per day and hence the authority of text has shifted the emphasis from knowledge imparter to educational facilitator. This was an opinion quoted by participant 12, who commented that lecturers could learn from students and are now "the guide on the side, rather than the sage on the stage" as learners take more autonomy over their own learning. A consequence of this approach and the rise of social media communication has been the development of communities or landscapes of practice (Wenger, et al. 2002).

The use of mobile mediated learning as a vehicle which permits an ease and convenience for learning may be compared with the communities of practice (COP) described by Wenger, et al, (2009) due to the use of collaborative social media groups. Participants use of WhatsApp in addition to email and Facebook as a primary method of communication, may be likened to the earlier definition offered by Wenger et al, (2002) as groups of people, passionate about a topic interact on an ongoing basis. The rehearsal and sharing of knowledge and clinical skills links act as sustainable and ongoing COP support groups whose objective is to deepen their knowledge and expertise in the relevant areas of clinical practice. Both self-generated content and links to both academic literature and social media form part of this supportive network. The use of smaller groups allows for a less restrictive social learning environment as participants are less concerned with the fear of being incorrect or judged in a less favourable light. Participants cite their dislike of situations where they may be more publicly visible and valued the ability and freedom to make mistakes. These were then analysed within small working groups and relevant action plans followed from these reflections.

This combination of technology influenced connectivist and social models of learning enhance understanding and promote enhanced cognitive functioning. Whilst the clinical practice environments in which Franz and Rowe (2013) contextualise this very argument still apply; this COP approach enhances physiotherapy education through the creation of a self-simulated environment in which learners set their own goals and outcomes.   COP have been revisited by Wenger and rather than a single community existing, the concept of a landscape of practice (LOP) has been deliberated, where learning is not cited within a single area of competency, but many areas exist where learners reside with varying levels of competency (Farnsworth, Kleanthous and Wenger-Trayner, 2016). The premise of these is that competence and skill development is negotiated over a time and involve a social process. Different members of the community may work with others on a similar task but can still learn together. Debates exist as to the differences between networks and communities of practice (Jewson 1997); however, as both networks and communities need connections to exist, the debate is understandable. The key aspect for a community or landscape of practice to exist is that a mutually agreed skill or skills are set. The collaborative goal of participant success in programme assessments usually ensure that this aspect is in place and drives much of the learning, but not exclusively so.

Whilst smaller COPs are obvious environments for skills development to occur, the concept of landscapes of practice (Farnsworth, Kleanthous and Wenger-Trayner, 2016) draws the discussion to the subject of the cohort influencers. Qualitative results from chapter 4 highlight how participants describe a smaller number of the cohort group who post information and links from the wider social media sites. Whilst it is beyond the aims of this thesis to conduct a detailed social network analysis, it is worth considering how landscapes of practice may compare with Granovetter (2018). The classic study of contacts from 1974 describes how many close contacts e.g., family, work colleagues, share similar contacts and thus share similar information about a subject. Granovetter studied changes of employment in a male population within the previous 5 years and states that rational choice was given little thought when acquiring a new job. The explanation was that this was due a limited information diffusal model where vacant job information came predominantly through close contacts. Granovetter (2018) introduced the argument of the 'strength of weak ties' as an explanation for this as everyone would be in possession of the same information about job availability. It was the less frequent acquaintances or 'weak ties' that new information came from and hence the most significant. The parallel in this study is that COPs allow close working peer groups to demonstrate similar traits to those described by Granovetter and perhaps represent the strength of strong ties. Skills therefore develop mutually and collaboratively i.e., everyone has the same information from similar academic or clinical contacts. The cohort influencers, however, who post resources to the group chat were participants who demonstrate the 'strength of weak ties' and would provide links to information through retweets or posted links from social media or their subscription acquaintances. This 'new information' could be acquired through clinicians from any area of the world, so long as they had an online presence and could involve both clinical skills, research studies, information from National Institutes e.g., NICE.

Evidence from the qualitative interviews suggest that the cluster analysis used following the survey questionnaire correctly identified high, middle, and low affinity users. Participant 19 cited from the interview that they were a structured, organised, and traditional learner who favoured a fixed environment with very clearly marked work and social boundaries. This participant favoured the use of non-mobile technology (predominantly laptop and PC) and demonstrated a very high composite score of 57 following analysis of their survey responses, hence had a low affinity for mobile technology. Participants 9 and 7 were assigned to clusters one and two after survey questionnaire analysis, with similar high scores of 41 and 45. These participants, however, were strong advocates of mobile when their interview data was analysed. All three participants mentioned above, were aged above 30 and had similar but not identical academic backgrounds. The differences were in part, attributable to the availability of technology. Two had access to larger mobile devices, i.e., tablet, whereas one did not, but did have access to a laptop. Sorgo, et al. (2017) states that the strongest predictor of information literacy was the non-use of a tablet which correlated negatively with information literacy which perhaps indicates participant 19 had the highest level of literacy. This may also help explain the use of an easy and convenient approach through tablet use as, if Sorgo et al. (2017) is correct, could indicate these are mare straight forward to use and require fewer skills of digital literacy.

Previous strategies, stigmas and digital curiosity all played their part in these decisions and opinions. This can also be likened to three other participants (1, 3 and 17) who were classified to clusters one (participant 1) and two after survey questionnaire analysis. Once more, all were aged 30 or above, but all showed low composite scores of 10, 14 and 11. All showed a genuine fear of being left behind by their younger peers and all then gained access to larger mobile devices (tablet) prior to or very early in the programme. The choice of a tablet rather than a laptop was a personal choice but may be linked to the ease of use of this device over a laptop in keeping with the TAM3 model of (Venkatesh and Bala, 2008). Ease of use is a primary consideration but TAM3 incorporates the construct of 'playfulness' and the importance of experience, enjoyment and expertise with technology. The experiences of these participants plus several notable others (Participants 5, 11, 13, 14) helped illuminate findings that showed how mobile could be used pro-actively and how a combination of collaboration mediated through mobile social media and personal resource creation e.g., video can be embedded into the overall personal learning strategy, possibly where participants are not as confident with personal computer video editing as is widely documented with digital wisdom (Prensky 2009).

Figure 4.34 illustrates the relationship that video, social media, and collaboration have with mobile learning. Mobile technology has been described in the results of this thesis as a vehicle by which participants access video from the world wide web/internet or self-create videos using their own smartphones. Relevant links or files are then shared in a collaborative way, using communication methods such as email, text or communication apps or communicated verbally through phone calls. Similarly, social media apps such as Facebook and Twitter act as learning portals through which participants access both video and text-based resources through their own subscriptions or 'feeds'. These subscriptions often link to other web-based resources and allow for sharing through a similar network of communication to web-based video or self-created content. This 'personalisation' of resources therefore brings together the video, social media, and collaboration elements of figure 4.34 through the network of communication and shows the relationship to the central vehicle of mobile mediated learning.

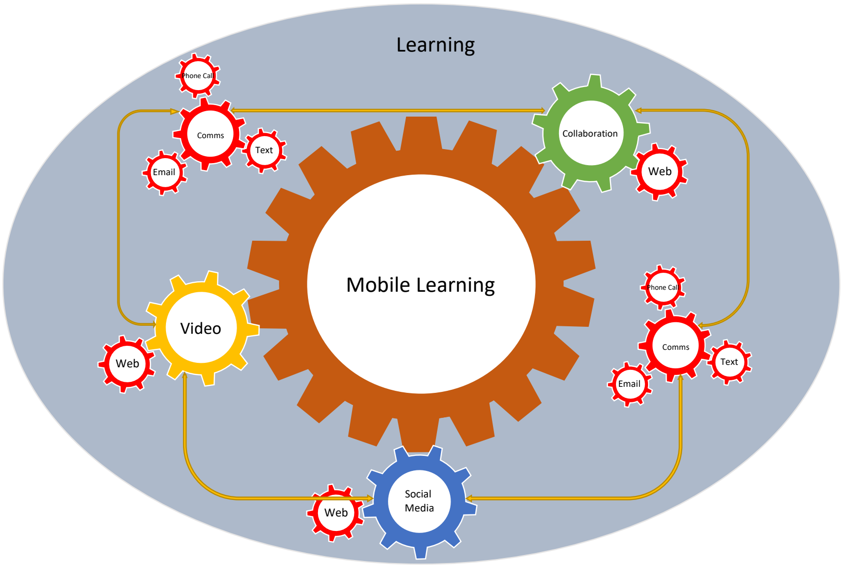


Figure 4.3. Demonstrates Relationship Between Personal Choice of Mobile Technology, Social Media Engagement and Facilitated Collaboration.

The six participants outlined above are excellent examples of how this study interpreted the personal construct as the key link that combines the technology with the other areas of figure 4.34 and how this may influence learning and drive learning strategies.

General Discussion.

This study aimed to explore the influence of one recent emergent method – that of mobile technology. The study asked the following research questions:

Thesis Research Question.

- How does a pre-registration student physiotherapy population use mobile mediated learning as a vehicle for learning in a specific professional context?

Quantitative Phase Research Question

- How do opinions of mobile mediated learning use vary and, therefore, drive learning behaviours in a pre-registration student physiotherapy population?

Qualitative Phase Research Question

- What influence do mobile technologies have on the learning of pre-registration physiotherapy students in specific contexts of physiotherapy education?

The definition of learning has many examples, from modification of behaviour through experience; acquiring skill or knowledge through instruction and study; however academic learning definitions usually involve some reference to the mode of teaching or a reference toward traditionalism or conventionalism. What is usually consistent is the acquiring of knowledge or skills, however, the manner of acquisition may occur using a multitude of different ways.

Chapter three showed that all pre-registration physiotherapy students included in the sample possess at least one mobile device which is primarily used as a communication tool rather than for learning purposes. The use of mobile for social media purposes was much smaller with 16% citing this as a use, however only 5% stated that they used their device primarily, for educational purposes. It is arguable that the use of social media was educational, given the qualitative evidence, however participants may have used social media for other social purposes hence did not consider this as educational. There were no clear differences between male and female participants, however a higher percentage of female participants possessed three or more devices (almost double that of male participants).

The survey questionnaire in chapter four identified, from cluster analysis, three separate groups who demonstrated differing opinions about the value of mobile learning. When used as an educational tool, the usage ranged from 2 hours for cluster three to just short of 6 hours per week for the other groups for purely educational learning. These figures link to the number of devices owned – median scores show that cluster three users possessed one device only (smartphone) as opposed to two devices (smartphone plus tablet) for other clusters (average median scores). The usefulness of mobile technology for learning was ranked 7/10 (median score) for the overall study population but was higher for clusters one and two than for cluster three (median scores of 8, 8 and 4). There was a clear difference between opinions from cluster three participants who showed significantly different opinions from the other groups in 10 of 14 opinion-based questions demonstrating less favourable responses to the usefulness of mobile technology for learning. This group demonstrated some agreement that access to resources mediated by mobile was a positive influence, however, the constructs of creativity and development showed a general disagreement. This contrasted with the other groups who demonstrated higher levels of agreement across all three constructs and thus a more positive opinion of mobile learning and arguably a more cohesive and connected approach to learning mediated through mobile.

Chapter four also generated a variance sample for semi-structured interviews from across the three groups and identified four themes which support the findings of the quantitative phase. The interview findings found qualitative evidence to suggest the value of multimedia is a more powerful learning tool than the quantitative phase initially suggested due to its ability to develop clinical skills, foster collaborative learning and reflection. Mobile technologies form an important support tool that engages both peer-based learners and individuals beyond their own learning culture groups through social media. Additionally, a collaborative approach through both online and face to face communities of practice helped facilitate both skill development (through video) and cognitive understanding. The implicit nature of this, suggests that mediated mobile learning is understated and that educators can utilise connectivist and social constructivist learning approaches to facilitate these skills. Institutions, therefore, may consider how learners can address barriers to mobile learning if a connected approach is a desirable pedagogy.

The commonalities of both phases of the study showed participants value the use of mobile technology for its quick, easy to use and convenient method of multimedia capture and consumption for assessment of performance and development of skills. The quantitative survey questionnaire reported the ability of participants to link concepts together using mobile mediated learning which was seen as a positive aspect, and this commonly held opinion was explored during the interviews. Here it was evident that mobile devices functioned as a useful supplementary and support tool but would not replace other types of approach e.g., pen and paper as the primary learning tool.

The linking of theoretical and practical concepts, however, offers insight into the development of both psychomotor and cognitive skills. Whilst multimedia has been shown in other studies to be a positive influence on learning, (Kemp, et al. 2010, Parson, et al. 2009, Moore and Smith, 2012), it does predominantly demonstrate vicarious and experiential approaches to assist the psychomotor development of clinical skills. The development of cognitive skills however is less clear, as video offers fewer opportunities to ask questions of educators. Moore and Smith, (2012), concluded that future studies should be developed that focus upon cognitive skill development separate to psychomotor skill development and suggested online repositories such as Twitter be used as a platform to ask questions. The accessibility of both video and Twitter via mobile applications which have an instant 'on' function rather than the 'login' process of laptops and desktops make these ideal options for the expeditious nature of modern learners. Integration of Twitter and other social media platforms alongside video create an argument for the confluence of psychomotor and cognitive elements of learning. The ability to create or watch multimedia content combined with the option to use a searchable platform such as Twitter (estimated 200 billion tweets per day, (internet live stats 2020) offer users access to a library of information that is unrivalled. Similarly, YouTube offers users access to both video and user comments that can help develop both cognitive skills and complement psychomotor skills. This was outlined by participant 14 who described the usefulness of third-party comments when viewing YouTube videos to facilitate theoretical understanding, suggesting a connectivist-constructivist fusion.

The ability of Twitter to 'filter' long form writing or the word limitations of YouTube 'user comments' therefore make this an appealing medium for learners demonstrating an expeditious approach to learning, where the user appears to adopt 'the fastest way to the answer' approach. The unavailability of academic staff to ask questions of, at unsocial times, may cause a behavioural approach that facilitates a 'filtered approach' to learning and adoption of social media platforms as learning environments. Kramer, Guillory, and Hancock, (2014), comment how social media influenced behaviour positively by acting as a newsfeed filter and Depala and Greene, (2016) comment on how hashtags such as #Physiotalk and #physio15 are used by physio students to facilitate discussion.

By using positive words in filtered newsfeeds, behaviour change was observed in users own posts in a similar pattern. Social media has been shown to influence and drive behaviour in many studies (Goodyear, Armour and Wood, 2017; Anderson and Perrin, 2017; Banks, 2018), hence the ability of social media to act as a cognitive filter is a plausible concept to drive behaviour and for 'cohort influencers' or 'information leaders' to emerge within year groups. The individual behaviour, driven by Twitter, Facebook etc. and communicated via sharing of links, likes, or through other platforms e.g., WhatsApp has potential to influence the 'educational pulse' of any learning cohort. Many examples are cited during the interviews that comment on the usefulness of peer sharing of content via social media links and affirms the value of 'digital praise' as a validation strategy for learners. Thus, digital praise (whether direct or indirect) has the potential to provide the necessary positive reinforcement to encourage cognitive skill development through collaborative learning and highlights the influence of mobile technology as a vehicle for social media learning. Hebron (2018), suggests that this goes beyond undergraduate experiences and can facilitate continuous professional development, research impact, and provide forums for health education.

The relative portability of some mobile technology however, e.g., smartphones, although convenient, does offer a more limited viewing experience of video type resources from social media sites due to the smaller screen. The emergence of tablets, tablet PCs and more latterly, slimmer, and lower weight laptops coupled with more powerful computing and software versatility have offered more popular viewing options. This smaller and lighter hardware also helps link the integration of psychomotor and cognitive skills using different hardware. Interviews with these participants, however, suggest far less involvement with Twitter, hence they use other social media options that offer a more private culture such as WhatsApp, offer the ability to ask questions in a more social constructive manner but without access to the huge knowledge database offered by Twitter.

Thus, mobile learning acts as a part in a larger learning process. The size of the part that it plays is dependent upon several factors. It is important that mobile technology is easy to use and has a particular useful role(s) to fulfil in student learning. Participants that use and engage with mobile technology can harness its potential to create, collaborate, communicate, and construct knowledge in a personalised manner at a time and place that suits them. The ability to find solutions to the barriers that are encountered with mobile technology helps identify users that have a higher level of digital capability and literacy with this type of mediated learning. This helps to foster development with mobile technology and creates a connected form of learning that can act in sync and promote understanding. This, however, does not represent the main learning strategy, but merely a vehicle to develop other digital strategies and media. Figure 5.1 builds on that shown in Chapter 6 and merges the findings of the qualitative phase with those of the survey questionnaire constructs. It suggests how a connected mobile approach represents added flexibility to learning but is, to an extent, dependent on overcoming barriers and distractions and thus bring mobile learning within the boundaries of their own learning strategies. Some barriers are related to hardware, which, given the pace of current development, should be more easily overcome. Purchase costs present another barrier which is more difficult to predict. The ability to bridge the gap that these barriers sometimes create is key to successful development of mobile mediated digital literacy.

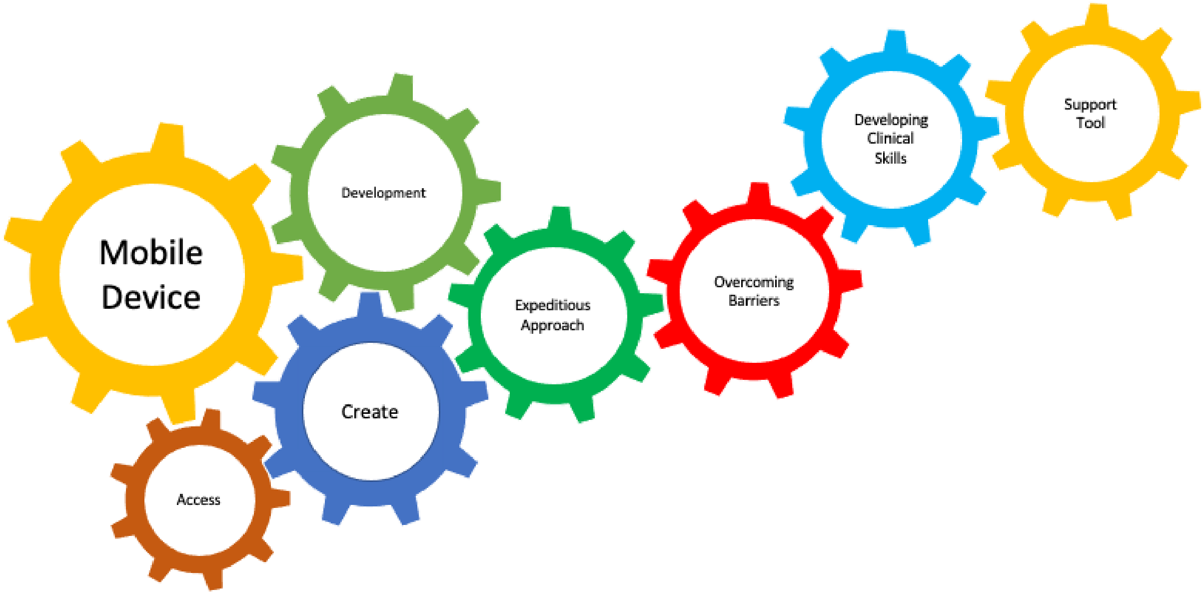


Figure 5.1 Suggested Process for a Connected Mobile Approach to Learning.

The diagram represents a suggested mode for connected learning mediated through mobile and shows how participants in this study successfully used mobile as a vehicle towards accessibility, creativity, and personal development. The expeditious approach facilitated by mobile allowed participants with a high affinity for this form of mediated learning to overcome barriers presented by mobile such as finding solutions to issues of incompatibility or creative uses for learning through non-traditional strategies such as through social media. The ability to use mobile as a supplementary learning strategy promotes a blended approach that dovetails with their predominant traditional entrenched strategies and widens their boundaries of learning. The ability to use mobile as a further support tool adds reflective strategies by allowing some experiences to be visible and available for analysis which may assist cognitive understanding through personal reflection and groups discussion. Participants who are not able to overcome these barriers (either by choice or through other circumstances cited above), demonstrate a disconnect in this area as shown in Figure 5.2 and hence adopt learning strategies where mobile technology is not ignored, however is used as a support tool or mechanism alongside their primary learning strategies. In this suggested model, development and expeditious approaches remain connected to each other, but as a 'detached' construct that is outside of that mediated by mobile e.g., via PC or laptop.   Clinical skills will continue to develop but the ability to overcome some of the barriers e.g., storage, data plans, battery life may contribute to the disconnect and arguably, constrain the development that self-captured video footage can offer. The more cautious approach to social media exploration resources can also feature as a barrier, though not necessarily a hardware or software barrier.

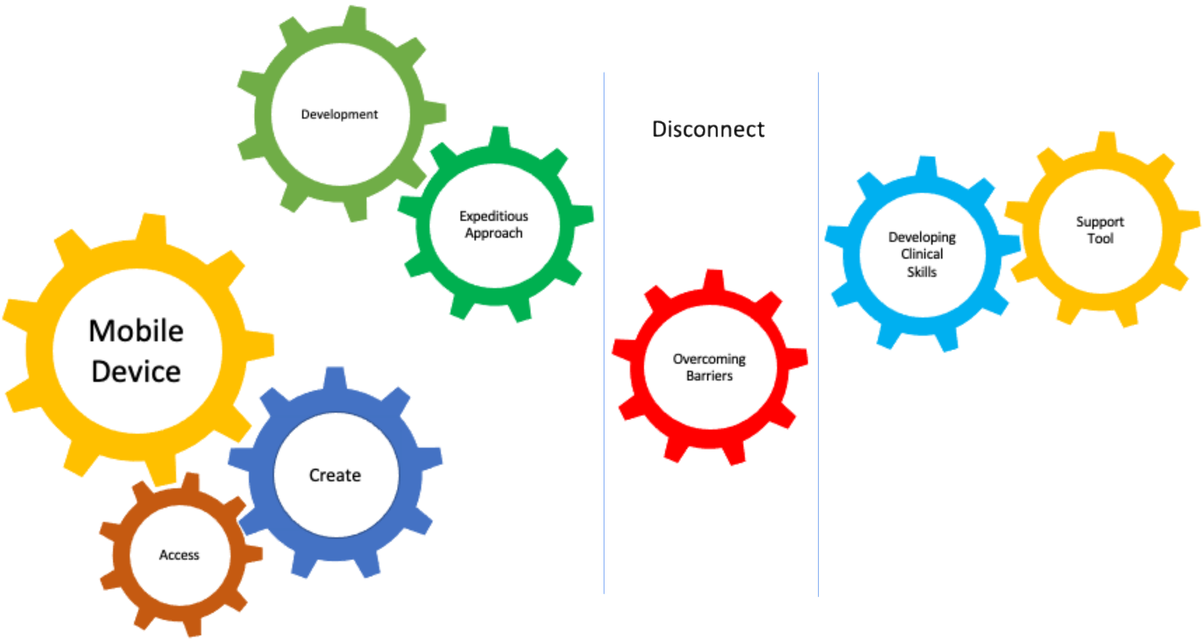


Figure 5.2 Suggested Process for a Non-Mobile Facilitated Approach to Learning.

Summary

Pre-registration physiotherapy students in this study use mobile mediated learning to develop their own clinical skills by accessing both staff and publicly available video content. They engage with content through the use of video capture, image capture and audio capture of their own clinical skills using personal mobile devices such as smartphones. These are then used, to reflect and develop their motor skills and cognitive understanding. Both quantitative and qualitative results of this thesis i.e. survey questionnaire statistics (Kruskal-Wallis tests) and cited quotes from semi-structured interviews support this finding.

Participants have significantly different views on the use and value they place on mobile mediated learning. Learning clinical skills through video capture is the most widely accepted and used strategy of mobile mediated learning. The survey questionnaire results demonstrate this is a widely held opinion and represents an easy and convenient approach that requires fewer skills of digital literacy. Access to social media through mobile apps such as Twitter, represent an approach to learning that is less widely accepted but can facilitate communities of practice of varying size. These can be small peer communities, larger cohort communities, or online global communities. The strength of these 'weaker ties' appears to be viewed positively due to the resources they provide, which filter down from large online communities to the smaller cohort communities. This filtering process is facilitated by 'cohort influencers' and thus filters down to the small peer communities. Cited examples from the semi-structured interviews have suggested that cohort influencers exist in this small sample and their collaboration and communication through social media links with theme 1. These uses represent the most valued methods and emerge from interview findings.

Mobile mediated learning offers a supplementary approach rather than an alternative approach to traditional learning resources. It is unlikely to replace face to face teaching for demonstration and practice of skills, but does provide a vehicle to develop skills by providing opportunities for reflection that traditional observation and feedback cannot. It offers a more autonomous approach to learning that complements concepts by offering access to a wide variety of online resources that were unavailable in previous decades. Students, however, should receive guidance regarding the quality and reliability of this material. It offers clarity by offering the ability to quickly check definitions, diagrams in classroom contexts etc. to aid understanding.

Some participants prefer structured and ordered environments that favour non-mobile mediated approaches and feature larger screens e.g. laptop, desktop over smaller smartphone screens. Barriers to mobile mediated learning include hardware issues such as poor battery life or storage capacity or may be related to connection availability such as poor Wi-Fi signals or low data plan allowances. These drive behaviours that favour non-mobile mediated approaches.

Those who are able to address these barriers, support the use of mobile mediated learning due to its ease and convenience. They are aware of methods to store data in other platforms to free storage or use accessories such as Bluetooth keyboards, whilst retaining the ability to access uploaded files. They were often mature students who purchased tablets and possibly did not have the same financial obstacles as younger students, who were less likely to purchase a second mobile device e.g., tablet. The smaller size of smartphones dictated that acceptance for certain tasks e.g., text document creation was low.

Mobile mediated learning is therefore an important support tool that can help develop clinical skills and competencies through use of self-created and publicly available video. It engages learners due to its ease of use and helps facilitate collaborative and individual learning through social media communications and face to face discussion. These may help facilitate both skill development (via multimedia) and cognitive understanding. The implicit nature of this, suggests that mediated mobile learning is an understated approach and that educators can utilise both social learning theory and connectivist models to facilitate these skills.

Implications for Practice.

The findings of this thesis describe the influence of mobile technology upon physiotherapy student learning in pre-registration contexts. The inter-relationship between development of clinical skills, the expeditious nature of mobile mediated learning and the ability to address and overcome barriers with technology raise some issues that educators within and outside of physiotherapy learning contexts can consider. The changing nature of educational delivery particularly at the time of writing during the 2020 COVID-19 pandemic, creates deliberations for educators who may not find change, easy. At the beginning of this thesis, the importance was directed towards fellow educators within physiotherapy education and the wider health care education sector, however the recent pandemic has major implications globally for the influence of mobile learning. The use of multimedia within education now has a major importance as face-to-face teaching has been restricted and has forced educators to look to other methods of delivery.

Many 'new' online classrooms are in or have been developed because of the lockdown that was introduced in March 2020 (Cullinane, 2020) and perhaps highlight the inequalities in education through varying levels of adaption to this new situation. The digital literacy and proficiency of students with all forms of technology (including mobile) is thus hugely important currently as a means of creating a viable home learning environment. Both students and educators are now having to adapt quickly to this changing educational landscape and will predictably, try to modify existing practices as described by King, (1993) well before access to the internet was available.

The emergence of communication platforms e.g., Microsoft ‘Teams’ during this pandemic has had global implications for world communication. Microsoft recorded a 12 million increase in users over a 7-day period and reports of 44m users have been cited (CNBC, 2020). Access via mobile technology has obvious attractions to users who value an expeditious approach and who value learning within online communities, hence adaptability of participants and digital curiosity to new technologies is a very important implication identified from this study. At a time when more users may be keen to explore education mediated through mobile technology, it is perhaps worth reflecting on the more understated elements of learning that mobile can offer and the nuanced relationship between epistemic resources and online collaboration.

The use of video to develop clinical skills is timely given that there is increased importance around connected medicine because of the pandemic. Using video to develop clinical skills may be seen as a useful vehicle to incorporate other skills such as remote consultations through mobile technology and self-appraisal of subjective assessment skills. These are important for the changing landscape of clinical placements, where the emergence of online clinical experiences necessitate a changing portfolio of skills for both students and clinical staff.

The inequalities that may potentially arise, do so because of financial implications. It was seen during the qualitative interviews that barriers such as poor battery life, poor data plans, and outdated hardware co-existed with lower levels of engagement with mobile technology. This, although not explicitly linked (during the interviews) to financial position, has implications in this current situation as access to resources will be driven by technology. Counter to this is the argument that an opportunity now exists where literacy levels rise and access to resources is embraced at a level, that previously did not exist due to previous entrenched methods of study.

Certainly, within the interview participants, several examples were seen where a 'movement' from one cluster to another was observed and hence the experiences stated at interview phase conflicted with those opinions of the questionnaire. This was discussed within the interview with participant 12, who commented how the purchase of a mobile device had initiated a change in learning approach. This suggests that an educational 'plasticity' exists where students can adapt to certain 'triggers' and action these accordingly e.g., purchase of a tablet, high-end smartphone. There are examples of this within the study where participants have returned high composite questionnaire scores (low affinity), but interviews suggest were huge collaborative influences (e.g., participant 12) or where this 'trigger' had occurred around or prior to questionnaire completion (participants 7 and 17).

There is an assumption that students all possess the necessary skills to engage with online learning, whether this is mediated through mobile or more fixed computers. What has emerged from the qualitative findings is that this is not the case and therefore, mobile mediated learning perhaps represents a less challenging approach due to the easy-to-use interfaces of apps. It does provide an opportunity for educators to encourage students however, to engage in continuous professional development independent of programme structures. Mobile does offer a form of unintentional learning whereby a student may access knowledge during periods of leisure time e.g., relaxing and browsing and commence an unplanned journey of discovery which results in higher levels of engagement in subsequent sessions. This connectivist approach is exciting for the user due to the autonomy it allows, but perhaps poses a threat to existing structures in higher education due to the perceived loss of content control and potentially unreliable information.

An argument could therefore be made that specific social media sessions or modules be incorporated into physiotherapy programmes with the aim of raising the level of understanding in areas such as research awareness, critical appraisal, information filtering, value of expert opinion etc. This has consequences for clinical practice as physiotherapy service users have the same level of access to these resources as everyone, hence similar patient education messages can be addressed both as simulated exercises and in periods of clinical practice.

The subtheme of 'fear of being judged' was a finding which discovered that some of the more mature students acquired digital skills that exceeded those of the younger and 'assumed' more digitally literate students. The younger participants who did use Twitter cited that they would not contribute and remained more passive observers of social media, whereas there were cited examples from more mature participants who did engage more actively and received replies from other 'more expert' users. This observation of adaptability and flexibility has implications for educators in physiotherapy and for disciplines outside of health care contexts. Consideration should be given of how to 'activate' this level of engagement, perhaps using early programme modules to gauge appetite and incorporate assessment activities such as social network analysis tasks around key themes. These can potentially be developed further during level 5 modules and incorporate participatory activities rather than solely analysis. The activation of this engagement is also an important implication for life-long learning within both current and post-registration health workers who share some of the barriers experienced by interview participants.

An additional finding of this sub-theme was that participants use of mobile mediated learning in classroom situations is constrained due to a fear of negative judgement by staff who assume smartphone use to be associated with non-academic pursuits. The implication for both staff and students therefore is to have an agreement to what constitutes acceptable practice in class. This is a moot point as many lecturing staff may consider a complete ban, whereas others may encourage their use, hence confusion for student users is probable. Programmes may therefore consider a 'code of conduct' for the use of mobile mediated learning within classroom settings to avoid unnecessary conflict.

Finally, there are implications for prospective students who are interested in joining the profession. The ability of online technologies to connect individuals dictates that future student cohorts may be offered either an online or face-to-face interview as part of the admissions process. Educators will need to consider the value of mobile mediated technologies to assess prospective recruits and if this best demonstrates their suitability for acceptance. Physiotherapy is a profession that provides expert assessment in movement through direct observation, examination and analysis, hence it will be important to project the correct message that mobile mediated connectability represents an alternate but not a primary vehicle for the profession.

Study Limitations.

Whilst a primary goal of this thesis was to examine an area of practice with the intention of integrating the findings into personal teaching philosophy, it should be recognised that limitations are inherent in the study (Robson and McCartan, 2016). The driver of the research question was the pragmatic approach using a mixed methods paradigm where the researcher must show proficiency in both areas by demonstrating key skills in qualitative and quantitative methods. The supervisory team in this regard (which has changed on numerous occasions) consisted of experts in quantitative and qualitative research, which, whilst partially addressing researcher limitations, could not address the issues inherent in design, data collection, data analysis and the gathering of rich qualitative data. This was executed by a novice researcher lacking experience in both paradigms, hence the potential for the quality of data gathered to be influenced by researcher reflexivity and the leading nature of qualitative interviews.

As an educator of pre-registration physiotherapy students, the research process is not unfamiliar, however the area of qualitative research does not reside within an area of personal proficiency. This was, in some part, the rationale for a study that involved a large qualitative aspect; to address an area of self-perceived weakness with the intention of developing proficiency. The use of nVivo for qualitative coding and indeed the whole of the qualitative data analysis was a voyage of discovery and one where several valuable lessons were learned. Firstly, the transcription process, although monotonous and time-consuming, was a hugely valuable process and expedited the process of familiarisation in a way that the use of a transcription service never would. Secondly, the use of an unfamiliar software package such as nVivo led to some self-inflicted complications in coding that were again, valuable but time-consuming lessons. The irony of this study was not lost during this phase as the use of video to learn how to use nVivo was invaluable, however did lead to some serious amounts of over coding. The result of this was an overwhelming amount of qualitative data that produced initial thematic frameworks that covered an entire wall and contained several duplicate codes. The combined use of nVivo, Excel and Word in conjunction with each other led to acquisition of several new skills that proved extremely useful in data management and for future research projects. Lastly, the qualitative journey was the longest phase of the study, due in part to the overwhelming nature as outlined above. This was accompanied by the quantitative researcher who resides within and is looking for the measurable mathematical answer. Alas, this proved to be friend (for the quantitative phase) and foe as much of the analysis was spent looking for the 'right answers' rather than the abstract interpretation. As the importance of documenting the transparency of the qualitative process was realised, the data analysis became more manageable and with it came the added realisation that this 'perceived' wastage of time was actually a hugely important phase in order not to rush the analysis.

The nature of the findings in this qualitative research however, yield results that have limited transferability to contexts (Bowling, 2014), hence the findings in this study must be taken in overall context and that data was gathered from undergraduate participants at a single Higher Education Institution. Findings therefore should be interpreted within this narrow context and reconciled with the knowledge that mobile technology is a rapidly changing subject, where environments shift quickly as outlined by Alrasheedi and Capretz, (2015), hence some findings in this study may already have been addressed by the marketplace.

Central to this argument is the collection of data from the pilot and main quantitative study, which may now be outdated due to the evolving nature of technological advancement. Alongside this is the sample size for the survey questionnaire (n=163), which in the context of the available HEI pre-registration physiotherapy population, represents around 77% of the total population, however due to the nature of the convenience sampling involved, cannot be generalised beyond this.

The use of a survey questionnaire for the initial phase was hugely rewarding in terms of the understanding of questionnaire methodology. The development of a questionnaire is a multi-stage process involving careful consideration of each phase. As the questionnaire developed, more questions around rigour than answers arose, resulting in a multi-stage approach to the data analysis. From initially approaching the internal consistency, further reading led to further analysis and ultimately, the realisation that the two phases of the study could integrate far more closely than was originally envisaged.

These combined limitations represent the limited scope of the thesis, however as suggested by Hewitt-Taylor, (2011), practice decisions often utilise research findings in a more limited capacity than are suspected. Thus, the integrated nature of theory, applied knowledge, and better-contextualised understanding in this population gives strong justification for implementation and further development of the approaches used for this study. Convenience samples of 163 may be considered small, however in the context of a single institution and small programme, this may be re-evaluated, and, in reality, represents a sizeable percentage of the overall target population (that of Northumbria Physiotherapy students).

Finally, the use of a mixed method approach has shown findings that are congruent between the quantitative and qualitative phases. There are, however, some divergent findings in the data (Questionnaire - Cluster three) which may result from the anonymity between the two phases. Creswell, et al. (2008) highlights that divergent finding can uncover new theories and insights; hence these may be important findings, but one must also consider the divergence in respect of questionnaire anonymity versus the non-anonymous methods used for interview data collection. The divergence of findings may also result from quantitative methods not being sensitive enough to detect complex experiences uncovered in the qualitative phase (Doyle, Brady and Byrne, 2016). In this study, this relates to the nature of non-parametric statistical testing and limitations of survey type data collection. In mitigation, the use of cluster analysis helped demonstrate key differences within the survey sample and helped reduce selection of a more biased sample for interviews. Few studies have explored the sample in this detail or demonstrated this type of reflexive approach to interview selection. For the writer, this avoided a more simplistic approach that would have been guided by personal knowledge of the potential participants. This likely would have resulted in a different sample to that chosen, hence should not be appraised with too critical an eye.

Reflexivity

The subject of objectivity raises the question of the position of the researcher and the difficulty in remaining objective. This is viewed to an extent as impossible to achieve and the subjective influence of the researcher in constructing meaning when reporting the study outcomes must be considered in more detail. The position therefore must be carefully examined and the guiding values of the researcher within the research process must be made clear (Cresswell 2007, Bryman (2008).

This thesis emerged because of observations I made in health-based Higher Education teaching and learning over the last decade. Initially, this observation surfaced when I noticed a small number of students who were strong enough to transport their heavy, bulky laptops to class with the idea to take notes in sessions or conduct work in the University library. With each subsequent year, it was noticeable that small changes occurred, and students would demonstrate, when compared to previous cohorts, a different array of study habits during lectures, seminars, and practical classes, but in their own different ways. Some students were happy to be assisted by technology, whereas others felt more comfortable purely with pen and paper. The introduction of first-generation Smartphones around 2007 marked a particular turning point as students began to explore and engage in this technology during taught sessions in a different manner and much more frequently. A different type of interactive classroom was beginning to emerge, where user-defined information could be accessed within taught sessions. Often apps that had been downloaded to these Smartphones were demonstrated to me and feedback was sought regarding their suitability for module content. The further development of tablet-based technology and much smaller, thinner, and more expensive but powerful laptops offered a further layer of options for students to choose from as these offered larger viewing screens and improved portability. It was very noticeable that, during theoretical lecture and seminar sessions, a wide variety of learning strategies existed. This then led to the deliberation as to their influence and usefulness with respect to educational learning in the context of Physiotherapy Theory and Practice. This provided the initial interest in this area and led to the development of the idea and methodology to investigate these observations. The emergence of technology also led to students being less dependent upon academic staff and allowed the students to become much more mobile as learners themselves as they were able to access information and knowledge on demand in environments that were previously impractical. In many observations, it was clear that the students possessed skills to access information, however they sometimes struggled to direct their learning in a constructive manner.

I wished, therefore, to know more about their experiences and uses with these emerging technologies to better understand if and how this was a productive way of learning and if it could offer anything to future pre-registration physiotherapy students and fellow educators alike. From a personal perspective, I found mobile technologies to be useful tools for communication but less so for developing clinical skills or research skills. This, however, is from a perspective where my own clinical skills have had many more years to develop. My own physiotherapy training and early professional career, though many years ago, gave much debate to how various assessment and treatment techniques were performed and a sense of recall bias would often reside amongst students and colleagues, hence the influence of mobile technologies in this regard (to capture techniques using their own technologies) was of great interest. As previously stated, interviews were conducted with participants in the knowledge that the researcher held no viewpoint on the influence of mobile technologies and that the interest in this research was purely with a view to gain better understanding of how these were used and the participants opinions around the value of such devices. In this regard, the researcher was attempting to demonstrate their unambiguous reflexivity by stating their own position (with a historical outline stated above) and avoid misrepresentation through member-checking exercises (Richards and Schwartz, 2002) both during the interviews themselves (via restating points and requesting respondent validation) and following interviews (participants were given opportunity to check the validity of transcripts and to comment on these).

An important consideration for the reflexive nature of the researcher and the challenges presented by member-checking is the methodological approach adopted within this thesis. The rationale for adopting the Framework Approach for the qualitative aspect of the thesis is the transparent nature of this and the ability of the reviewer to see the process and counteract any unintentional bias. It can also reduce the risk of priori knowledge biasing the findings, which does not imply that this is absent, but it is merely acknowledged to be a factor and minimised during analysis. Whilst the involvement of other analysts would allow for multiple perspectives (Greenhalgh 2014), all analysis was done by the researcher, thus one perspective from a teaching and learning/physiotherapy background was considered. Whilst the researcher did not keep an explicit reflexive journal, many reflections upon the journey were observed. Some of these have previously been outlined in the study limitations.

Future Research.

Whilst the key aim of this study was to investigate the influence of mobile technology on pre-registration physiotherapy student learning, it must be considered that this is a small population, and findings cannot be generalised to other populations. It would however be an obvious extension of this study to explore if similar experiences and influences are found within other health care and social science populations. The nature of the NHS Health and Care Digital Capabilities Framework make other populations such as nursing, medicine and allied health professionals, obvious student populations to explore further. In addition to this, digital literacy, and the link to flipped classrooms make educators an obvious population of interest. Hessler, (2017) cites five principal areas of resistance to flipped classrooms that foster the use of mobile learning. These include loss of control, mistrust, fear of the unknown, bad timing and an individual's predisposition toward change. These areas would be useful to explore and perhaps converge with findings from student populations to uncover the barriers and facilitating factors behind flipped classrooms and engagement with technology.

Another key aim of the study was to develop an mlearning questionnaire as an exploratory tool to assess the appetite of both individuals and cohorts for mobile learning. This questionnaire developed three constructs around which an assessment may be made. Further development of the mlearning questionnaire is possible by addition of other questions which may develop further constructs as seem with the original TAM model (Davis, 1989). Whilst the TAM model was developed over several years, the rate and uptake of technology in the present climate would most likely see a more expedient development. This would again be subject to further measures of reliability and validity before it could be used usefully as an outcome measure for any quantitative research.

Original Contribution to Knowledge.

The convergence of findings from this study have developed the educational evidence base in several ways. Firstly, there are few mlearning questionnaires that explore personalised and autonomous technology acceptance. There are the broader technology acceptance models, however their limitations have been documented in this study and central to the argument is their use with institutional technology acceptance, which is often mandatory. Some mlearning questionnaires exist, however, to the knowledge of the writer, this is the first questionnaire to be developed for pre-registration physiotherapists. This study presents an opinion-based questionnaire that can be used to predict the influence of mobile technology on pre-registration learning. The significance of this contribution is that it may give an insight into the appetite and use amongst student populations for mobile technology at a time that the UK Government have identified the importance of developing these skills in health-care pre-registrations as outlined in the Digital Framework. The use is not limited solely to pre-registration physiotherapist or health-care students and could be used for other social science populations. The study, using statistical analysis, identified participants who reported high, medium, and low affinities for mobile mediated learning. Using hierarchical cluster analysis and follow up discriminant function analysis, this study has ensured as objectively and as unbiased as possible, that the selection of participants recruited, represent opinions of maximum variance, i.e., positive, negative and neutral opinions, and established a better understanding of usage in pre-registration participants than has previously been reported in the physiotherapy literature.

Secondly, the survey questionnaire identifies how descriptive grouping variables may be used with the questionnaire to assist educators in identifying differences in student opinion toward learning with mobile technology. The significance of this is that it offers a quick and convenient method of gauging the heterogeneity of a group and propose strategies to develop learning at a time when assisted online learning through technology is hugely topical. Future cohorts who may engage with a more hybrid approach would also benefit from awareness of their own preferences and education around the contexts that mobile mediated learning can offer e.g., the use of video capture to enhance practical and clinical skills.

Thirdly, this study explores the individual experiences of pre-registration physiotherapists across their physiotherapy education rather than a specific knowledge area and proposes the influence that mobile technologies have on their professional learning. There are studies from the physiotherapy literature that investigate digital technologies in physiotherapy education. Olivier et al. (2020) conducted a scoping review of 52 studies that explore technology in physiotherapy and occupational therapy education. Of the 52 studies, only five were from the UK and did not explore how mobile mediated learning through self-generated resources support professional skill development, hence the findings from this study represent a contribution to the existing literature from this viewpoint.

Fourthly, the barriers to mobile mediated learning are presented extensively in this thesis and describe how barriers imposed by inflated costs, poor data plans, poor wi-fi and cellular connectability and fear of negative judgement (presented as a theme), highlight some key reasons why physiotherapy students may not engage with mobile mediated learning. It is not necessarily that they hold negative opinions, but the barriers restrict its usage.

Whilst many studies represent aspects of learning mediated through mobile, none have reported collectively on the influence that mobile mediated technology has upon learning throughout the programme. This thesis reports findings from self-generated resources across a range of subject area and assessment type e.g., practical examination, oral presentation, placement preparation etc. and describe how individualised approaches to this foster learning within different contexts of learning.

This study makes suggestions as to the influence that mobile technologies have in student learning within this population by identifying emergent themes and also how there may exist within the cohort, differences in mobile mediated literacy levels that may be linked to previous study and perceived use of mobile technology. It presents findings that demonstrate the value of self-created and social media generated videography for learning and the value of autonomous learning across the student journey. Given that the global pandemic has and will continue to affect pre-registration learning in both physiotherapy education and higher education in general, it is hugely important to explore how learners adapt to continuing change. This thesis documents findings that may provide an important insight into student learning behaviour prior to this adaptation.

Summary and Conclusions.

The study aimed to explore the influence of mobile technology upon student learning in a group of pre-registration physiotherapy students. Three multi-layered survey constructs revealed different opinions were prevalent and classified participants into three separate groups. The constructs identified differences between the groups but were unable to identify specific reasons. A purposive sample of 23 participants from these groups identified four emergent themes of 1. development of clinical skills, 2. expeditious learning, 3. barriers, and distractions and 4. use as a support tool.

The development of clinical skills theme revealed that participants used multimedia creation and consumption, as a predominant strategy to develop skills. The ease of video capture using smartphones, facilitated review and reflection and were primary features for the popularity of this as well as the ability to share files easily. The sharing of files promoted collaboration within various communities of practice at different 'levels' from small peer working communities to social media online communities, which may have facilitated greater cognitive understanding via connectivist and social constructivist learning theories. This suggests that learning mediated through mobile is a much-understated learning strategy than first appears although lecturing staff should be mindful that they should offer social media guidance and raise awareness of feeds from unreliable sources or non-registered practitioners.

The ease and convenience of using mobile mediated learning, appeared from the survey questionnaire to be higher in participants from clusters one and two, due in part to the ability to address and overcome barriers presented by mobile. Where participants did not overcome these barriers, participants were able to adopt other developed strategies such as laptop and desktop technologies to complement learning alongside their other primary learning strategies and develop literacy with these technologies.

Use as a support tool was the primary use of mobile technology. It is unlikely to replace other strategies as a main learning tool in the opinions of study participants; however, it appears to serve a much greater implicit influence that first appears. Whist an expeditious approach was favoured when speed and convenience were primary concerns e.g., foundation knowledge, quick fact checks or assessment confirmations, the value of reflection and collaboration should not be understated. The use of video lectures, demonstrations and recorded seminar resources therefore are areas with huge potential to develop clinical and academic skills. Although educators should be mindful of Aldous Huxley who quoted pre-1963,

> *Technological progress has merely provided us with a more efficient means of going backwards.*

If they can leverage mobile technology to develop clinical skills and foster meaningful collaborative enquiry through communities of practice, then connected learning mediated through mobile has the potential to play a much more explicit influence in pre-registration physiotherapy. The words of Tesla (1926) may then become.

> *A device small enough to fit into a vest pocket would be the instrument through which learning would occur, irrespective of distance.*

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Appendices

Appendix A

mLearning Questionnaire

mlearning Questionnaire

1. Are you

Male ☐

Female ☐

2. How old are you ___ Yrs.

3. Please give details which best describes your academic background immediately prior to entering University (Tick 1 only)

A Levels/Highers ☐

Access Course ☐

Previous Degree ☐

Diploma ☐

Other ☐

Please give details if you have responded with “Other”:

4. What Programme of study are you

BSc Hons ☐

MSc ☐

Diploma ☐

Year of study (Circle) 1 2 3

5. How many mobile devices do you own (this is not including laptops, netbooks or PCs)?

____

6. What type of device do you own

- Tablet/iPad ☐
- Phone ☐
- Phablet ☐
- iPod ☐
- Other ☐

Please give details if you have responded with “Other”:Please note that laptops, netbooks and PCs are not classed as mobile devices.

7. What is the primary use for your mobile device (tick 1 box only)?

- Recreational e.g., Games, YouTube, ☐
- Social e.g., Twitter, Instagram ☐
- Educational e.g., Blackboard, Podcasts ☐
- Communicational e.g., email, WhatsApp, Snapchat etc. ☐
- Lifestyle e.g., shopping, fitness ☐

8. What type of device do you own/use

- Android device ☐
- Apple/iOS device ☐
- Windows ☐
- Other ☐
- Not known ☐

Please give details if you have responded with “Other”:

9. Where do you use your device?

Please rank in order of importance where 1 is most important and 5 is least important. Please numbers once only, e.g., if you use your mobile most at home and least at work, then these would be ranked number 1 and number 5 respectively.
So, in the example below, the student would rank
Placement as 1 (most important),
Home as 2,
At work as 3,
In transit as 4 and finally
University as 5 (least important).
"Other" is Not Applicable (N/A) in this example

Home	1	2	3	4	5	6	N/A
University	1	2	3	4	5	6	N/A
Place-ment	1	2	3	4	5	6	N/A
In transit	1	2	3	4	5	6	N/A
At work	1	2	3	4	5	6	N/A
Other State____	1	2	3	4	5	6	N/A

Please rank in order of importance where 1 is most important and 5 is least important. Please numbers once only, e.g., if you use your mobile most at home and least at work, then these would be ranked number 1 and number 5 respectively.

Home	1	2	3	4	5	6	N/A
University	1	2	3	4	5	6	N/A
Place-ment	1	2	3	4	5	6	N/A
In transit	1	2	3	4	5	6	N/A
At work	1	2	3	4	5	6	N/A
Other	1	2	3	4	5	6	N/A

Please circle each COLUMN only once

Please give details of where you use your device in University e.g., during lectures, seminars etc. and for what purpose.

10. Which areas of University online content do you access via your mobile device (tick all that apply)?

Timetable	☐
Library Services	☐
Uni Facebook Account	☐
Email	☐
Sport Northumbria	☐
eLP	☐
Citrix Gateway	☐
Twitter	☐

11. Do you use your mobile device(s) to access University content via the Blackboard/eLP app?

Yes	☐
No	☐

Please give details of which areas:

12. Do you use your device for educational use other than through University content e.g., anatomy apps, physiology apps, research websites etc.

Yes	☐
No	☐

Please give details:

13. How often would you access University content using your mobile?

Several times daily	☐
Daily	☐
X 4-5 per week	☐
X 2-3 per week	☐
Weekly	☐
Fortnightly	☐
Monthly	☐

Please comment on reasons for choices to Q13

14. Approximately how many hours per week would you use your device for University work?

Device 1 ______No. of hours ___________(Type of device)
Device 2 ______No. of hours ___________ (Type of device)
Device 3 ______No. of hours ___________(Type of device)

15. Using a scale from 0-10, where 10 is most useful and 0 is not useful at all, where would you rank mobile learning as a learning tool?

Not useful 0 1 2 3 4 5 6 7 8 9 10 Most useful

16. Which learning methods do you find most useful – please rank these 1 to 8 in order of importance where 1 is most useful and 8 is least useful. Please numbers once only.

Lectures	☐
Seminars	☐
Practical	☐
Individual Study	☐
Directed Group Work/Study	☐
Non-Directed Group Work/Study	☐
E Learning	☐
mlearning	☐

17. What is your own preferred learning style (You may tick more than 1)

Visual	☐
Audio	☐
Read/Write	☐
Kinaesthetic/Experiential	☐

18. Please rate the statements below from 1-5 where 1 is strongly agree and 5 is strongly disagree

a) I use my mobile device as my primary source of learning on my course/programme.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

b) I find it useful to use my device(s) to record/store notes from University

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

c) I find it useful to use my device(s) to research new and unfamiliar ideas introduced at University

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

d) I use my device(s) to challenge and clarify my existing ideas around concepts learned at University

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

e) I use my device(s) to improve current knowledge by accessing learning resources e.g., professional journal articles, YouTube videos, relevant websites, Social Media feeds e.g., Twitter

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

f) I use my device(s) to create audio or visual learning resources to assist learning e.g., voice memos/podcasts, videos of clinical skills, photographs of relevant skills etc.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

g) I use my device(s) to create documents to assist reflection and organisation e.g., lecture/seminar notes, assignment plans, Gantt charts

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

h) I use my device(s) to challenge my existing ideas by considering other arguments from relevant websites, feeds etc..

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

i) I use my device(s) to assess my performance and skills e.g., by video capturing and analysing my performance of skills.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

j) I use my device(s) to convert leisure or unproductive time into productive time via accessing learning resources e.g., during commuting, between commercial tv breaks, etc.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

k) I use my device(s) to supplement my existing learning.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

l) Mobile learning helps me to make links to types of information and helps connect these together easily e.g., a resource (e.g., website, YouTube video, Twitter feed, Facebook link) may have a link or links to other learning resources, e.g., YouTube etc. that aid my understanding of a course concept.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

m) I feel confident that I am equipped to use mobile devices to effectively facilitate my learning.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

n) I would like to see sessions that demonstrate the uses of mobile learning within taught sessions in University

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

o) I would like to see sessions that encourage the use of mobile learning within taught sessions in University

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

19. Do you use your device for any collaborations/projects to share?
Information e.g., email, Twitter, Facebook, Snapchat, YouTube etc.

Yes ☐
No ☐

Please give details of what apps and how they are used.

20. Please list the 10 apps that you use most frequently (please place top 5 in order of priority/usage with number 1. being most frequently used
    1.
    2.
    3.
    4.
    5.
    6.
    7.
    8.
    9.
    10.
21. Please give brief details of reasons and uses for the choices in Question 20.

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.

Appendix A Part 2

Opinion / Attitude Statements

a) I use my mobile device as my primary source of learning on my course/programme.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

b) I find it useful to use my device(s) to record/store notes from University

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

c) I find it useful to use my device(s) to research new and unfamiliar ideas introduced at University

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

d) I use my device(s) to challenge and clarify my existing ideas around concepts learned at University

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

e) I use my device(s) to improve current knowledge by accessing learning resources e.g., professional journal articles, YouTube videos, relevant websites, Social Media feeds e.g., Twitter

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

f) I use my device(s) to create audio or visual learning resources to assist learning e.g., voice memos/podcasts, videos of clinical skills, photographs of relevant skills etc.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

g) I use my device(s) to create documents to assist reflection and organisation e.g., lecture/seminar notes, assignment plans, Gantt charts

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

h) I use my device(s) to challenge my existing ideas by considering other arguments from relevant websites, feeds etc..

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

i) I use my device(s) to assess my performance and skills e.g., by video capturing and analysing my performance of skills.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

j) I use my device(s) to convert leisure or unproductive time into productive time via accessing learning resources e.g., during commuting, between commercial tv breaks, etc.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

k) I use my device(s) to supplement my existing learning.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

l) Mobile learning helps me to make links to types of information and helps connect these together easily e.g., a resource (e.g., website, YouTube video, Twitter feed, Facebook link) may have a link or links to other learning resources, e.g., YouTube etc. that aid my understanding of a course concept.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

m) I feel confident that I am equipped to use mobile devices to effectively facilitate my learning.

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

n) I would like to see sessions that demonstrate the uses of mobile learning within taught sessions in University

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

o) I would like to see sessions that encourage the use of mobile learning within taught sessions in University

1	2	3	4	5
Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

Please circle the most appropriate response

Appendix B

Interview Guide

Focus of Interview Questions for Qualitative Phase

History of Devices

Could you talk me through the mobile devices that you have owned – this includes phones, tablets or mini-tablets but not laptops.

What was the reason that you chose these devices?

Do you change your devices on a regular basis? If so, what is rationale for changing?

What uses do you have /how do you use your device for everyday activities?

How would you rate your proficiency when using your devices for these activities?

How would you describe yourself as a learner i.e., what are your preferred styles/methods of study?

What has influenced these?

What do you understand by the terms e-learning (electronic learning) and m-learning (mobile learning)?

What are your experiences of using this type of learning for University learning?

What has shaped these views?

Do you feel that there are advantages and disadvantages to these types of learning?

Can you tell me your thoughts about these?

Further questions are very dependent upon the responses from respondents. Further questions will seek to explore barriers and opportunities to this type (mlearning) of learning.

These may include:

Why they use devices for specific tasks and not for others.

How long spent using this type of learning e.g., per day, per week etc. – what influences this?

Are mlearning sessions typically structured or non-structured i.e., do links/connections made may lead user in different directions on different occasions etc. or is it structured to supplement existing learning?

Opinions regarding future of this type of learning in Higher Education, clinical education and profession in general.

Appendix C

Consent, Information and Debrief Sheets

Informed Consent Form

Faculty of Health and Life Sciences

A GENERIC INFORMED CONSENT FORM

Project Title: An explanatory study examining the impact of mobile learning technologies in Pre-registration Physiotherapy Students.

Principal Investigator: Michael Parr

	please tick where applicable
I have carefully read and understood the Participant Information Sheet.	☐
I have had an opportunity to ask questions and discuss this study and I have received satisfactory answers.	☐
I understand I am free to withdraw from the study at any time, without having to give a reason for withdrawing, and without prejudice.	☐
I agree to take part in this study.	☐
I would like to receive feedback on the overall results of the study at the email address given below. Email address……………………………………………………………………	☐

Signature of participant...	Date.....………………….
(NAME IN BLOCK LETTERS)..…………………………	
Signature of Parent / Guardian in the case of a minor	
Signature of researcher...	Date.....………………….
(NAME IN BLOCK LETTERS)..…………………………	

Questionnaire Information Sheet

Title of the research study.
An explanatory study examining the impact of mobile learning technologies in Pre-registration Physiotherapy Students.

Name and contact details (email only) of the researcher
Mr. Mike Parr
m.parr@northumbria.ac.uk

Institution where the research is being conducted
Northumbria University, Faculty of Sport Exercise and Rehabilitation

Appropriate information about the study, and what participating will entail

1. What is the purpose of the project?
As technology progresses, new ways of interaction and learning evolve. The current rise of the handheld device is changing the way that the populations learn and behave. As a result, learning is no longer static and confined to classrooms, libraries or private study areas, it now has much more flexibility. A mobile device can be defined as any device that the user is capable of interacting with for a short period of time whilst standing up. The aim of this questionnaire is to examine and explore the current interactions and tools used by health care students that define mobile learning and their patterns of use. This research will contribute to future studies as it will inform the researcher of key strategies that students use and help develop questions and ultimately learning theories that are fostered using this approach

2. Why have I been selected to take part?
This research centers around the current use of mobile learning tools in health care student populations at both undergraduate and postgraduate levels. The aim of the questionnaire is to explore what current tools are being used, by whom and how. Therefore, groups of students from these fields will be asked to complete the questionnaire to answer this query.

3. What will I have to do?
There are no special requirements necessary other than to complete a written questionnaire in the English Language in permanent ink. This can be done at any time of day and then returned to the researcher as outlined below.

4. What are the exclusion criteria (i.e., are there any reasons why I should not take part)?
There are no specific exclusion criteria, though it is generally understood that by owning or having access to a mobile learning device is important to participate fully and complete the questionnaire.

5. Will my participation involve any physical discomfort?
No. Participation simply involves completing a written questionnaire

6. Will my participation involve any psychological discomfort or embarrassment?
No. The questionnaire can be completed in private if you desire and returned anonymously to the researcher in a sealed envelope. Alternatively, if you feel comfortable completing the

questionnaire in the presence of the researcher, it may be handed to them directly. The choice is completely optional.

7. Will I have to provide any bodily samples (i.e., blood, saliva)?
No. Just your experiences and practices using mobile learning are required!

8. How will confidentiality be assured?
A number of procedures will be used to protect the confidentiality of your data. These include:

A participant code will be used to identify any data that you provide. Your name or other personal details will not be associated with your data, for example the consent form that you sign will be kept separate from your data questionnaire.

Only the research team will have access to any identifiable information; paper records will be stored in a locked filing cabinet and electronic information will be stored on a password-protected computer. This will be kept separate from any data and will be treated in accordance with the Data Protection Act.

9. Who will have access to the information that I provide?
Any information and data gathered during this research study will only be available to the researcher identified in the information sheet. Should the research be presented or published in any form, then that information will be generalized (i.e., your personal information or data will not be identifiable).

10. How will my information be stored / used in the future?
All information and data gathered during this research will be stored in line with the Data Protection Act and will be destroyed 5 years following the conclusion of the study. During that time the data may be used by members of the research team only for purposes appropriate to the research question, but at no point will your personal information or data be revealed. Insurance companies and employers will not be given any individual's information, samples, or test results, and nor will we allow access to the police, security services, social services, relatives or lawyers, unless forced to do so by the courts.

11. Has this investigation received appropriate ethical clearance?
Yes, the study and its protocol has received full ethical approval from the Northumbria University Ethics Committee.

12. Will I receive any financial rewards / travel expenses for taking part?
There are no cash incentives for taking part; however, your responses may be beneficial to students in future cohorts who may benefit from the conclusions of this research.

13. How can I withdraw from the project?
The research questionnaire that you will complete will be more valuable if fewer people withdraw, so please discuss any concerns you might have with the investigator. During the study itself, if you do decide that you do not wish to take any further part then please inform one of the research team as soon as possible, and they will facilitate your withdrawal

and discuss with you how you would like your data to be treated in the future. After you have completed the research you can still withdraw your data by contacting one of the research team (their contact details are provided in section 14.

"If, for any reason, you wish to withdraw your data please contact the investigator within a month of your participation. After this date, it may not be possible to withdraw your individual data as the results may already have been published. As all data are anonymised, your individual data will not be identifiable in any way"

14. If I require further information who should I contact and how?
If you have any further questions, wish to register a complaint, or wish to withdraw your data, please contact me via email (m.parr@northumbria.ac.uk) or by telephone 01912156625.

Interview Debrief Sheet

PARTICIPANT DEBRIEF

Participant code:

Name of Researcher: Michael Parr

Name of Supervisor: Dr Matt Kiernan

Project Title: An explanatory study examining the impact of mobile learning technologies in Pre-registration Physiotherapy Students.

1. What was the purpose of the project?
As a lecturer in Physiotherapy, I have developed an interest in the ways that students use mobile devices during University teaching sessions. These devices range from phones, tablets, and mini tablets. More and more, these are being brought into taught sessions, hence I am interested in exploring the ways in which these are used and the technical proficiencies that are required in order to benefit or gain no benefit from their use. The purpose of this project therefore is to explore the experiences and opinions of Physiotherapy students when using mobile devices for learning. I am conducting this study as part of a PhD thesis examining the impact of mobile devices on student learning

2. How will I find out about the results?
Results will be available through a number of channels. Interested participants will be asked to indicate on the consent form if they would like to be informed of the results via email. Those who would like to receive this information will be asked to provide an email address to which results can be sent. Should any aspect of the study be published in scientific journals, then the results will be available in the public domain. Regular post-graduate researcher seminars at Northumbria University allow results to be disseminated via oral-visual presentations.

3. Have I been deceived in any way during the project?
The interview recruitment and interview process are designed to be a transparent process. The information sheet should provide you with the details of the study and what it intends to achieve. The consent form is designed to reassure you that the process allows you the right to refuse to take part or to withdraw from the study at any time. The issue of confidentiality should assure you that anything you say during the interview will remain confidential and that should written transcripts be published, your identity will be protected so that you cannot be identified and will remain anonymous. Prior to the interview, you should have been provided with a brief outline of the questions that were asked and given the opportunity to ask any questions to clarify anything that you were unsure of. All of the steps mentioned above are designed to prevent any deception during the project.

4. If I change my mind and wish to withdraw the information I have provided, how do I do this?
You have the right to withdraw from the study at any time by contacting the PI either by using the email below, by written notification addressed to the PI at the School of Life Sciences, Northumbria University or by telephone.

The data collected in this study may also be published in scientific journals or presented at conferences. Information and data gathered during this research study will only be available to the research team identified in the information sheet. Should the research be presented or published in any form, all data will be anonymous (i.e., your personal information or data will not be identifiable).

All information and data gathered during this research will be stored in line with the Data Protection Act and will be destroyed **12** months following the conclusion of the study. If the research is published in a scientific journal it may be kept for longer before being destroyed. During that time the data may be used by members of the research team only for purposes appropriate to the research question, but at no point will your personal information or data be revealed. Insurance companies and employers will not be given any individual's personal information, nor any data provided by them, and nor will we allow access to the police, security services, social services, relatives or lawyers, unless forced to do so by the courts.

If you wish to receive feedback about the findings of this research study then please contact the researcher at **m.parr@northumbria.ac.uk**

This study and its protocol have received full ethical approval from Faculty of Health and Life Sciences Research Ethics Committee. If you require confirmation of this, or if you have any concerns or worries concerning this research, or if you wish to register a complaint, please contact the Chair of this Committee (Dr Nick Neave: nick.neave@northumbria.ac.uk), stating the title of the research project and the name of the researcher:

Interview Information Sheet

Faculty of Health and Life Sciences

Study Title: An explanatory study examining the impact of mobile learning technologies in Pre-registration Physiotherapy Students.

Investigator: Michael Parr

You are being invited to take part in this research study. Before you decide it is important for you to read this leaflet so you understand why the study is being carried out and what it will involve.

Reading this leaflet, discussing it with others or asking any questions you might have will help you decide whether or not you would like to take part.

What is the Purpose of the Study?

The purpose of this study is to explore the views, opinions and experiences of Physiotherapy students in Higher Education around the use of mobile devices for learning. It is important to find out how students are using these devices e.g., mobile phones, tablets, mini-tablets in their learning and to explore whether they are perceived to be beneficial. Although more and more students are engaging with learning in more flexible ways, it remains to be seen if they students perceive them to be useful.

Why have I been invited?

As a Physiotherapy pre-registration student, you are eligible to take part in the study. Previously, you have completed a questionnaire about your engagement with mobile learning. Your responses to this questionnaire indicated that you would be willing to talk more in-depth about your experiences and opinions around this subject.

Do I have to take part?

No.

You have the right to refuse and also the right to withdraw at a later date if you feel uncomfortable with any part of the study

What will happen if I take part?

The Principal Investigator (PI) will contact you via email and arrange a mutually convenient time. This should be timed to coincide with a time of day that allows a 'reasonable' amount of time prior to and following the interview. You will be asked to read an information sheet and sign a consent form agreeing to take part in the study.

The study involves a 30–40-minute interview in which the PI will ask you a series of questions about your experiences of using mobile devices for learning and your opinions about this type and style of learning. The interview questions will be open ended to allow you to provide as much or as little information as you desire. After the interview, you will be asked to read and sign the debrief form to document how you feel or if you have been affected by the interview process. This allows the PI to make a judgement about any advice/counselling that may be needed.

What are the possible disadvantages of taking part?

There are no predicted disadvantages of taking part. The PI is interested in your opinions and the aim is to explore how mobile devices impact on student learning. This may be in a positive sense, but also it may be in a negative way. It is important to listen to different viewpoints in order to understand what are the barriers and triggers that drive or prevent this type of learning.

What are the possible benefits of taking part?

There are no direct benefits of taking part. This is to say that there is no financial reward or incentive for taking part. The benefits of taking part are in the contribution that your opinions make to this subject area. This may not be immediately apparent, but the benefit is that it will add to the knowledge around this subject area.

Will my taking part in this study be kept confidential and anonymous?

A number of procedures will be used to protect the confidentiality of your data. These include:

A participant code will be used to identify any data that you provide. Your name or other personal details will not be associated with your data, for example the consent form that you sign will be kept separate from your interview transcript.

Only the PI will have access to any identifiable information; paper records will be stored in a locked fil-

All information and data gathered during this research will be stored in line with the Data Protection Act and will be destroyed 5 years following the conclusion of the study. During that time the data may be used by any members of the research team only for purposes appropriate to the research question, but at no point will your personal information or data be revealed. Insurance companies and employers will not be given any individual's information, samples, or test results, and nor will we allow access to the police, security services, social services, relatives or lawyers, unless forced to do so by the courts.

What will happen to the results of the study?

The results will contribute to a larger study examining the impact of mobile devices on learning in Higher Education. This will be available via University electronic link on completion in line with future University protocol. The specific results of this study may be disseminated via seminar and conference presentations or via publication in targeted journals.

Who is Organizing and Funding the Study?

This study is part of a PhD which is funded by Northumbria University.

Who has reviewed this study?

The study has been reviewed by the Northumbria Ethics Committee (Department of Sport, Exercise and Rehabilitation)

Contact for further information:

e.g., Researcher email: m.parr@northumbria.ac.uk
e.g., Supervisor email matt.kiernan@northumbria.ac.uk

Name of another person who can provide independent information or advice about the project

Appendix D

Search Strategy

Details of Search Strategy

The literature was important to frame the research question and inform the approach to the methodology. Whilst the existing evidence base had limitations in the context of studies around the influence of mobile mediated learning within physiotherapy, it was important to identify this, along with emergent studies with relevance to the profession.

Searches were performed using core bibliographic databases: CINAHL via EBSCO, MEDLINE, AMED, Scopus plus the commercial database, Google Scholar. Initial pilot searches using these databases used the following terms

- Mobile learning OR mlearning OR mobile

Combined with either:

AND physiotherapy OR physical therapy OR rehabilitation

AND student OR undergraduate

When using Google Scholar, the terms were amended to reflect the 'operators' used in this database

- "Mobile learning" |mlearning|mobile
- allintext: "Mobile learning" |mlearning|mobile

Combined with either:

+physiotherapy|"physical therapy"|rehabilitation

+student| undergraduate |education

Search Results

Database search 1991 - 2021	Number of references
CINAHL	94
MEDLINE	163
AMED	22
Scopus	151
Google Scholar (allintext:)	88, 300 (59, 500)
Allintitle:	280

As this was not a systematic review, inclusion and exclusion criteria were not applied rigidly to the retrieved studies, however relevance to the research questions were considered and if relevant, were included. A relatively small number of studies were returned from the initial search results, of which, studies that explored wearable/SMART technologies or that related to clinical studies were not included. Search terms were broadened to include specific devices such as tablets, smartphones, or iPads. These were used with/without broader terms such as “digital” OR “technolog” and social media sites such as Twitter, Facebook, YouTube, WhatsApp etc. and combined using Boolean operators with “physiotherapy” and related terms.

- Tablet OR iPad OR mobile OR smartphone OR SMART devices
- Combined with either:

AND physiotherapy OR physical therapy OR rehabilitation
AND student OR undergraduate

+physiotherapy|”physical therapy”|rehabilitation
+student| undergraduate (Google Scholar Limiters).

Search Results

Database search 1991 - 2021	Number of references
CINAHL	15,167 (Aug 2021)
MEDLINE	300 (Aug 2021). 64 (2019)
AMED	522 (Aug 2021)
Scopus	46
Google Scholar (allintext:)	1,050,000
allintitle:	28

Search results from this yielded a much higher number of studies and hence were combined with the search terms

- Social Media OR Twitter or Facebook OR WhatsApp OR YouTube
- Digital OR technolog
- Video OR audio OR podcast

- Combined with either:

  AND physiotherapy OR physical therapy OR rehabilitation
  AND student OR undergraduate

  +physiotherapy|"physical therapy"|rehabilitation
  +student| undergraduate (Google Scholar Limiters).

Search Results

Database search 1991 - 2021	Number of references
CINAHL	34 (Aug 2021)
MEDLINE	300 (Aug 2021). 64 (2019)
AMED	167 (Aug 2021)
Scopus	134
Google Scholar (allintext:)	856,000
Allintitle:	3

Screening of results was performed by removing duplicate studies and consideration of titles/abstracts for relevance to the research questions for both phases of the thesis. Studies not written in English were not considered for inclusion in the literature review. Clinical studies and those involving SMART technologies were also not considered for inclusion in the review. Studies with similar methodologies were explored to consider both results/findings and ideally, methodological rigour e.g., consistency, validity, and reliability statistics. Greenhalgh (2014) comments that database searching can miss relevant articles, hence the reference lists of relevant articles and the 'related article' and 'cited by' functions of Google Scholar were also used to retrieve further relevant studies. A hand search of professional and educational technology journals was also performed from 2015-2020. These included, British Journal of Educational Technology, International Journal of Mobile and Blended Learning, in addition to professional journals such as Physiotherapy and Physical Therapy.

Summary of Search Strategy Key Words.

Database	**Search terms**
CINAHL via EBSCO Host	• Mobile learning OR mlearning OR mobile • Tablet OR iPad OR mobile OR smartphone OR SMART devices • • Social Media OR Twitter or Facebook OR WhatsApp OR YouTube • Digital OR technolog • Video OR audio OR podcast • Combined with either: AND physiotherapy OR physical therapy OR rehabilitation AND student OR undergraduate
MEDLINE	Same search terms as CINAHL
AMED	Same search terms as CINAHL
Cochrane Central Register of Controlled Trials	Digital AND therapy
Scopus	Same search terms as CINAHL
Google Scholar	• allintext: “Mobile learning” |mlearning|mobile • allintext: Tablet|iPad|mobile|smartphone|”SMART devices” • allintext:”Social Media”|Twitter| Facebook|WhatsApp |YouTube • allintext: Digital|technology|technologies • Combined with either: +physiotherapy|”physical therapy”|rehabilitation +student| undergraduate

Appendix E

Kruskal-Wallis and Post-Hoc Test Statistics

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of I use my mobile device as a primary source learning is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of useful to store and record notes is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of use to access new and unfamiliar knowledge is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
4	The distribution of use to understand and challenge or clarify new concepts is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
5	The distribution of use to improve current knowledge and access to resources e.g., YouTube is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
6	The distribution of use to create audio visual resources video is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.255	Retain the null hypothesis.
7	The distribution of Use to create documents and assist reflection and organisation e.g., Gantt charts is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.020	Reject the null hypothesis.
8	The distribution of use to challenge existing ideas considering other arguments is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.001	Reject the null hypothesis.
9	The distribution of use to assess performance and skills is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.594	Retain the null hypothesis.
10	The distribution of use to convert unproductive time into productive time is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.026	Reject the null hypothesis.

11	The distribution of use to supplement existing learning is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
12	The distribution of helps link to other types of information that aid understanding is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.285	Retain the null hypothesis.
13	The distribution of feel confident I am equipped to use device to facilitate learning is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.021	Reject the null hypothesis.
14	The distribution of would like to see sessions demonstrate mlearning is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.017	Reject the null hypothesis.
15	The distribution of would like to see sessions encourage mlearning is the same across categories of 5 variable cluster.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is 0.050

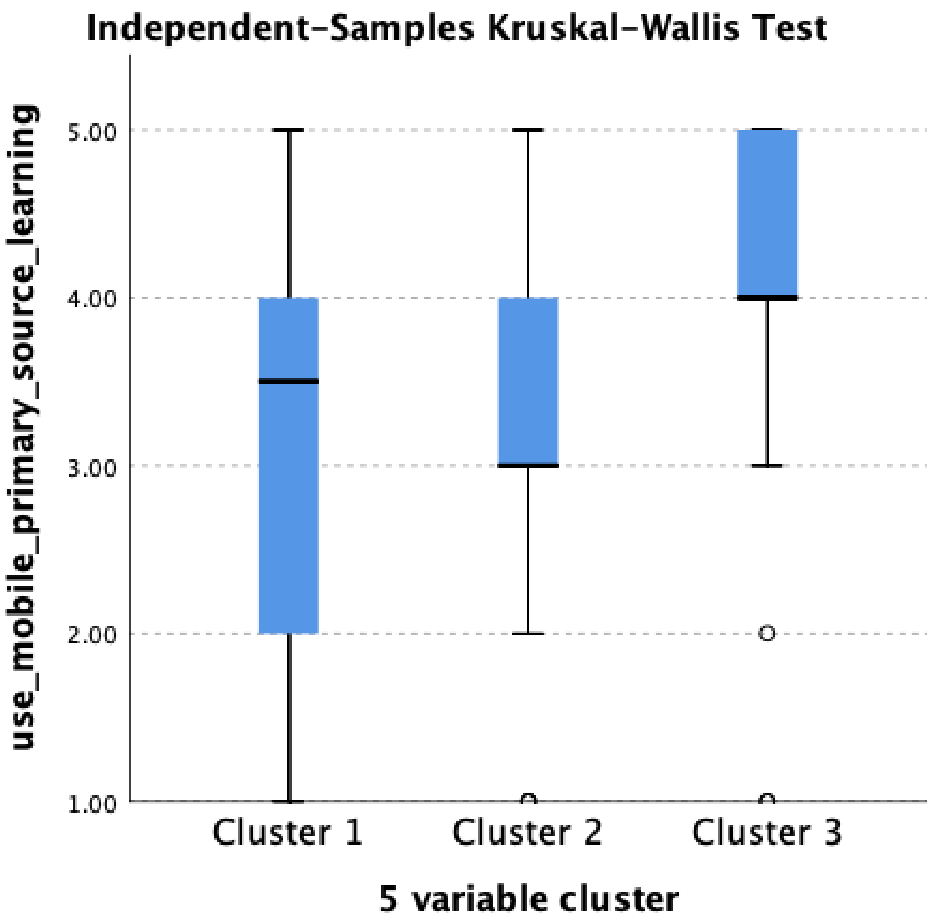
Independent-Samples Kruskal-Wallis Test

Use mobile primary source learning across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	18.647[a]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.000

a. The test statistic is adjusted for ties.



Pairwise Comparisons of 5 variable cluster

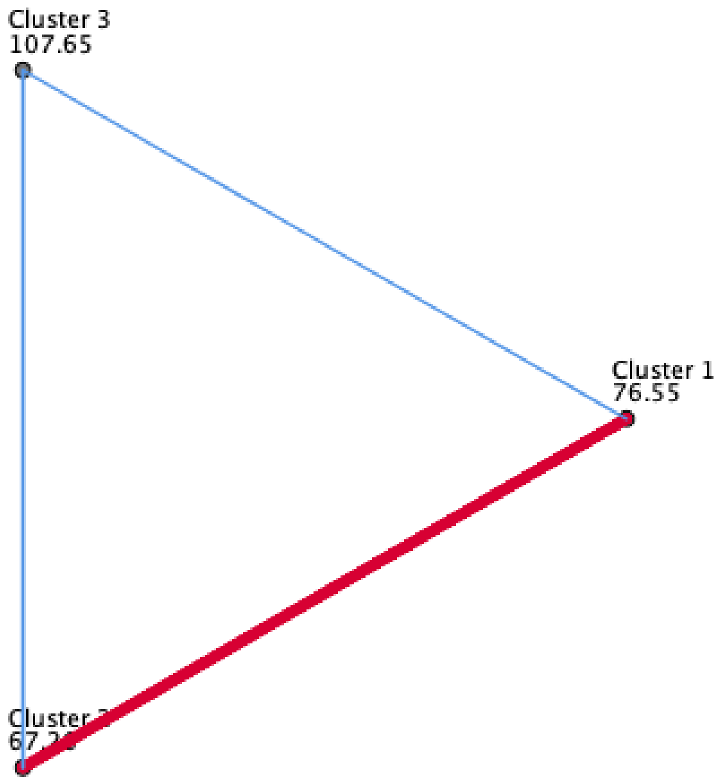
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statis-tic	Sig.	Adj. Sig[a]
Cluster 2-Cluster 1	9.286	7.879	1.179	.239	.716
Cluster 2-Cluster 3	-40.385	9.394	-4.299	.000	.000
Cluster 1-Cluster 3	-31.099	9.833	-3.163	.002	.005

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Pairwise Comparisons of 5 variable cluster



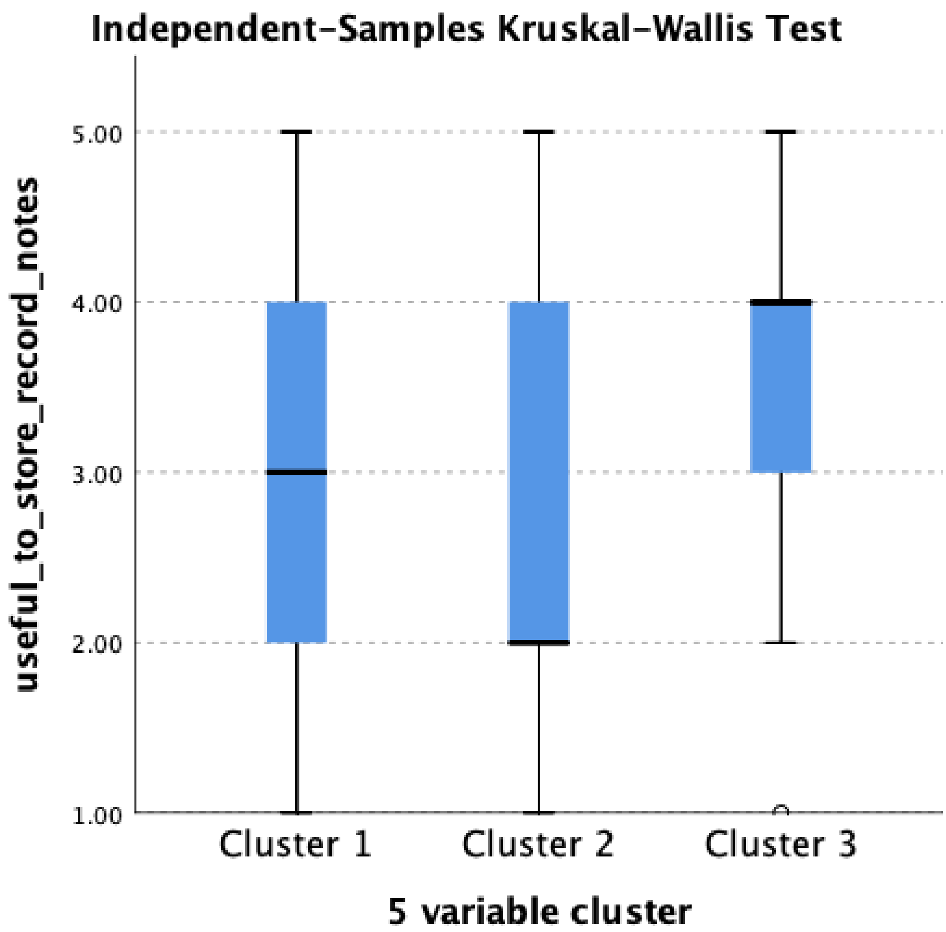
Each node shows the sample average rank of 5 variable cluster.

Useful to store record notes across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	15.259[a]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.000

a. The test statistic is adjusted for ties.



Pairwise Comparisons of 5 variable cluster

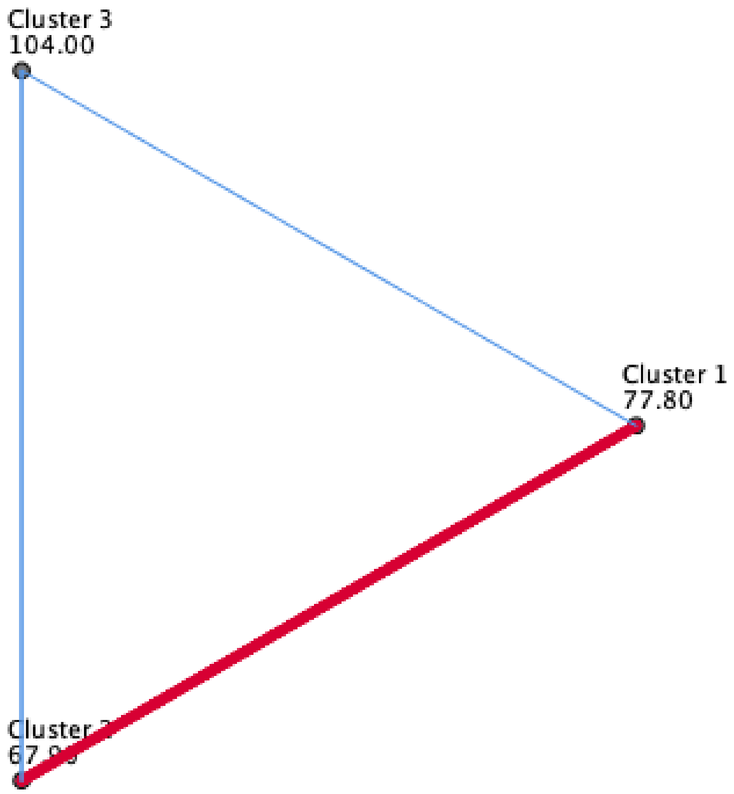
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statis-tic	Sig.	Adj. Sig.[a]
Cluster 2-Cluster 1	9.895	7.757	1.276	.202	.606
Cluster 2-Cluster 3	-36.099	9.248	-3.903	.000	.000
Cluster 1-Cluster 3	-26.204	9.680	-2.707	.007	.020

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Pairwise Comparisons of 5 variable cluster



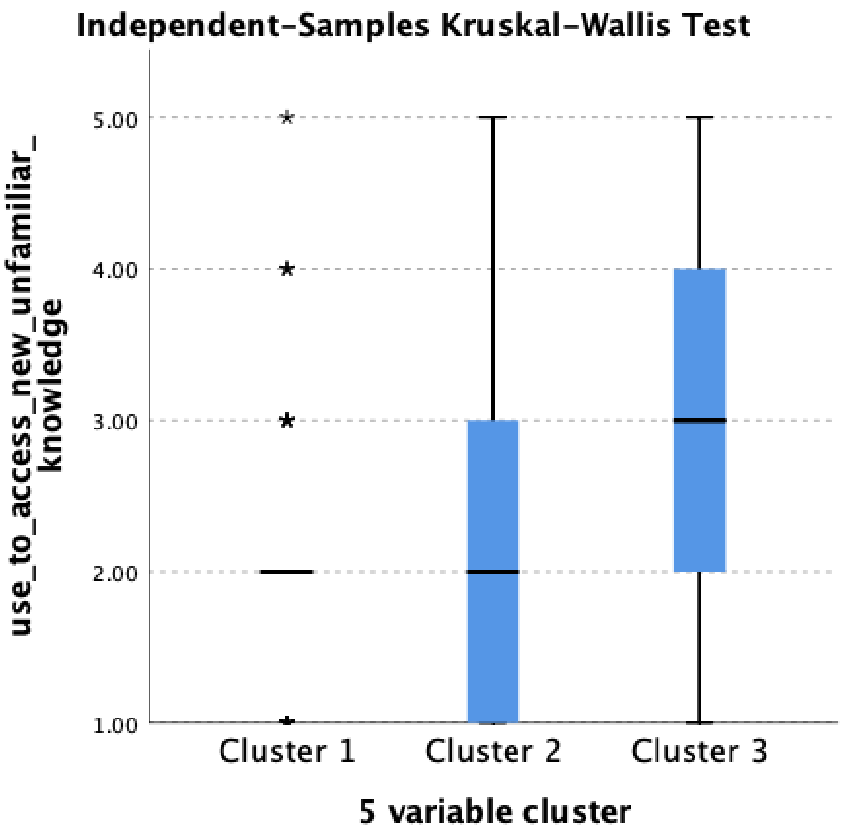
Each node shows the sample average rank of 5 variable cluster.

Use to access new unfamiliar knowledge across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	15.258[a]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.000

a. The test statistic is adjusted for ties.



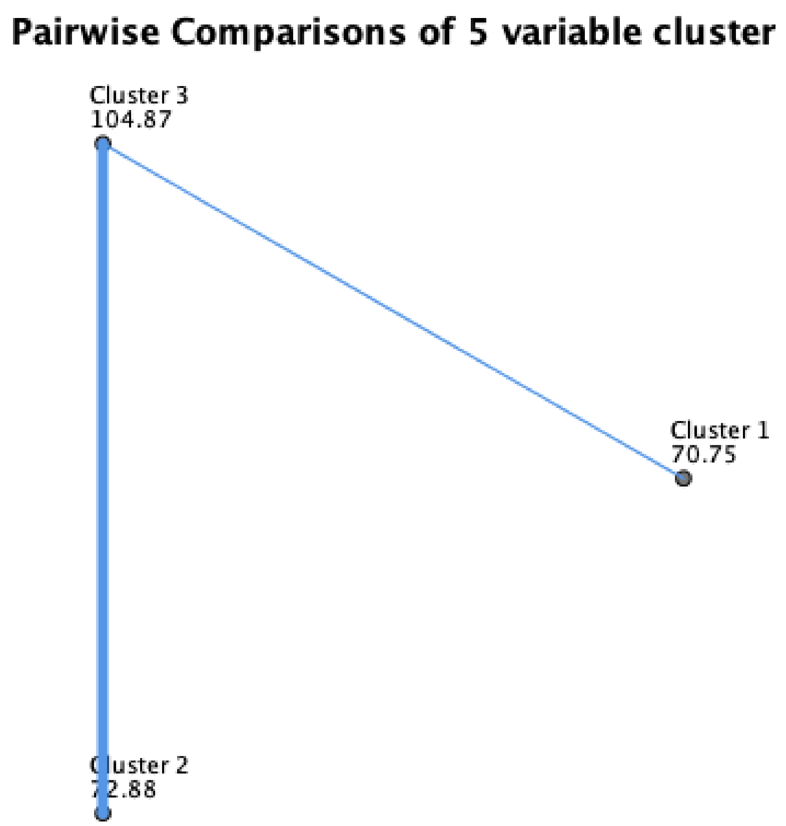
Pairwise Comparisons of 5 variable cluster

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Cluster 1-Cluster 2	-2.130	7.602	-.280	.779	1.000
Cluster 1-Cluster 3	-34.121	9.487	-3.597	.000	.001
Cluster 2-Cluster 3	-31.991	9.063	-3.530	.000	.001

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.



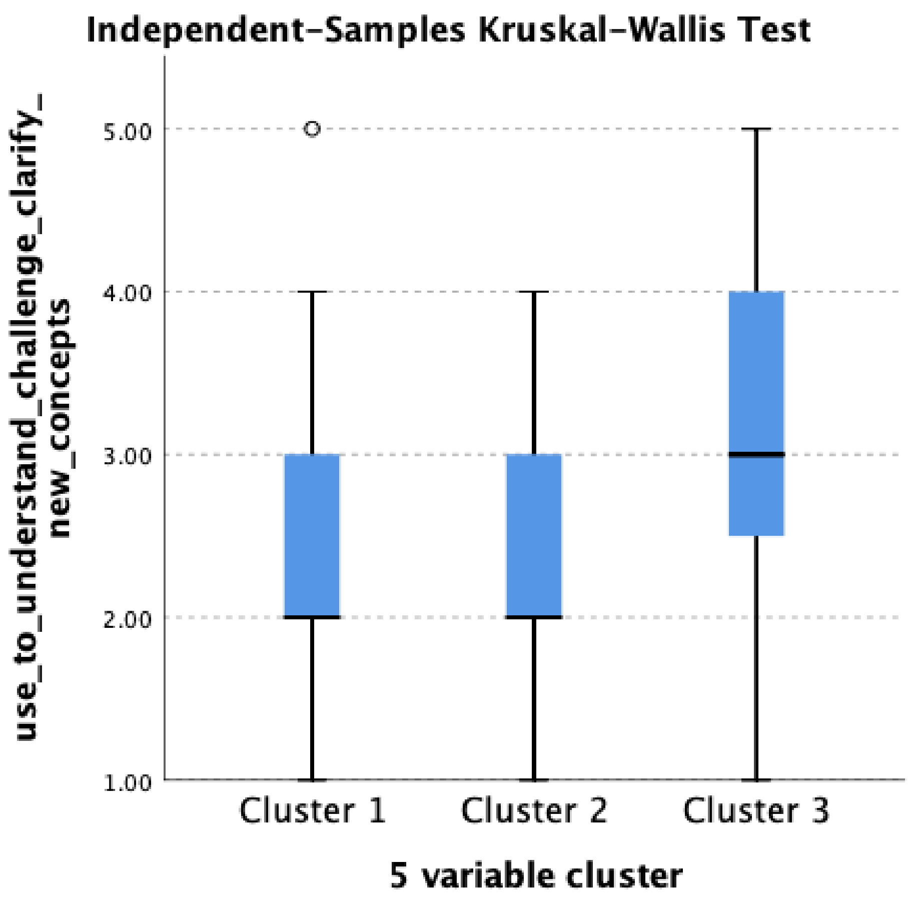
Each node shows the sample average rank of 5 variable cluster.

Use to understand challenge clarify new concepts across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	17.192[a]
Degree of Freedom	2
Asymptotic Sig.(2-sided test)	.000

a. The test statistic is adjusted for ties.



Pairwise Comparisons of 5 variable cluster

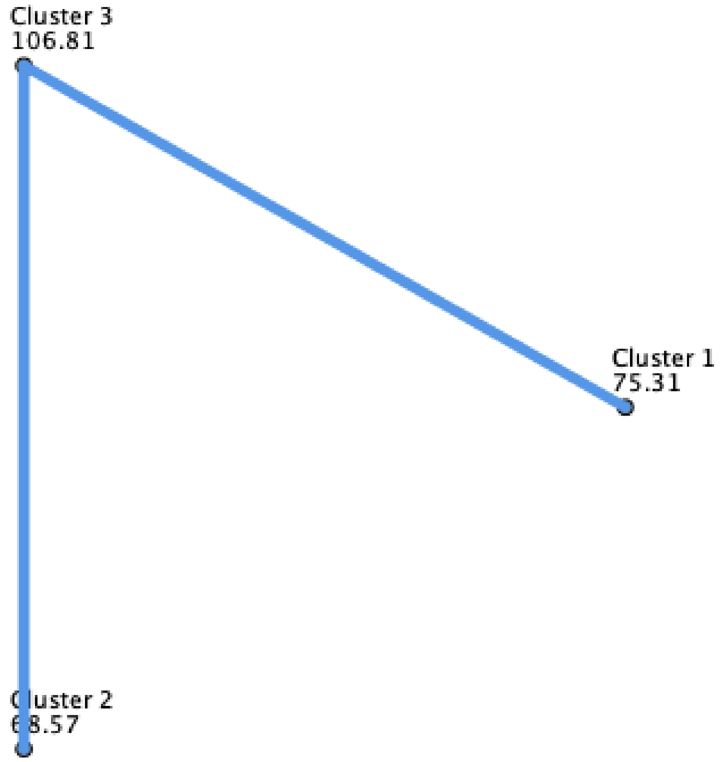
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Cluster 2-Cluster 1	6.735	7.837	.859	.390	1.000
Cluster 2-Cluster 3	-38.236	9.344	-4.092	.000	.000
Cluster 1-Cluster 3	-31.501	9.781	-3.221	.001	.004

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Pairwise Comparisons of 5 variable cluster



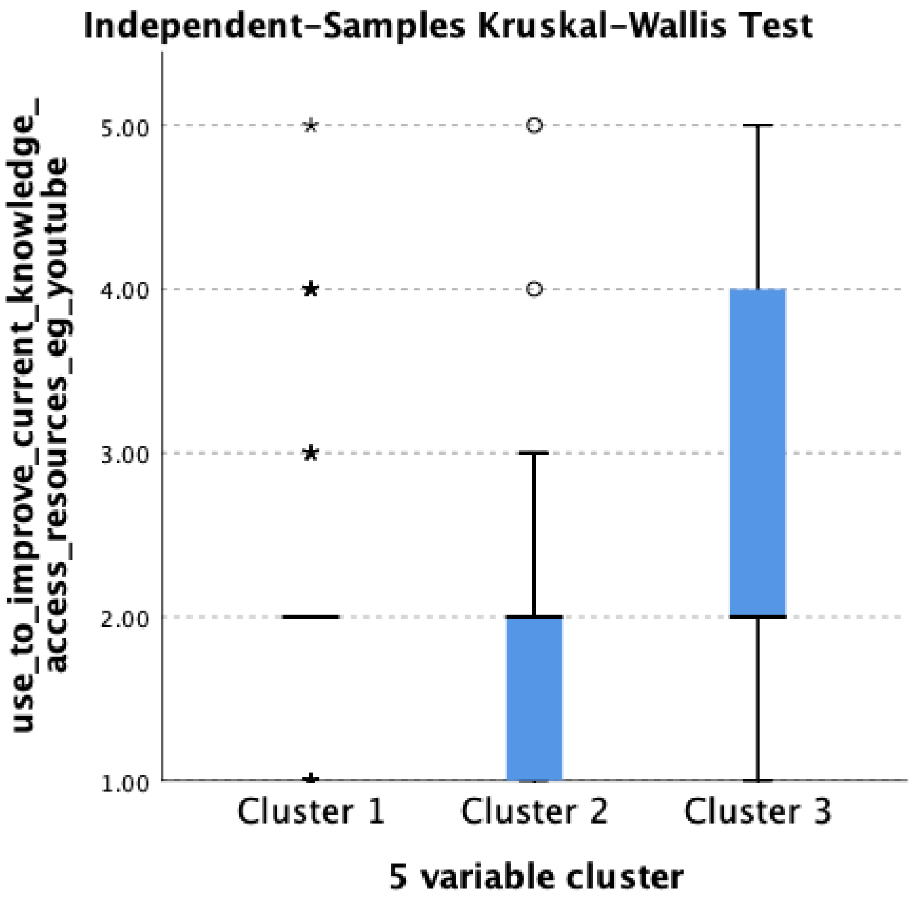
Each node shows the sample average rank of 5 variable cluster.

Use to improve current knowledge access resources e.g., YouTube across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	16.596[a]
Degree Of Freedom	2
Asymptotic Sig.(2-sided test)	.000

a. The test statistic is adjusted for ties.



Pairwise Comparisons of 5 variable cluster

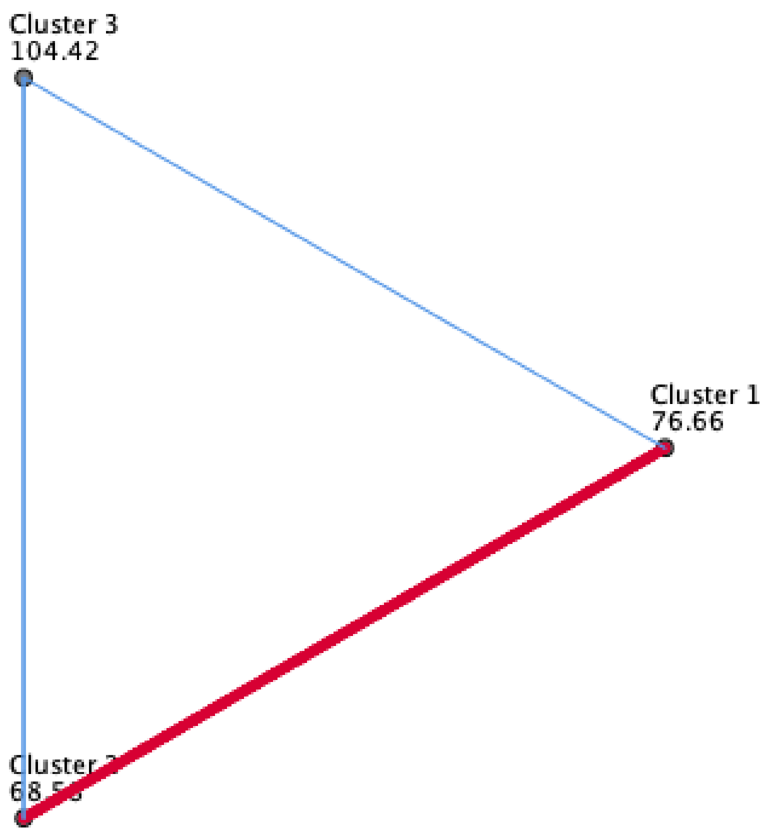
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statis-tic	Sig.	Adj. Sig.[a]
Cluster 2-Cluster 1	8.073	7.415	1.089	.276	.829
Cluster 2-Cluster 3	-35.835	8.841	-4.053	.000	.000
Cluster 1-Cluster 3	-27.762	9.254	-3.000	.003	.008

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Pairwise Comparisons of 5 variable cluster



Each node shows the sample average rank of 5 variable cluster.

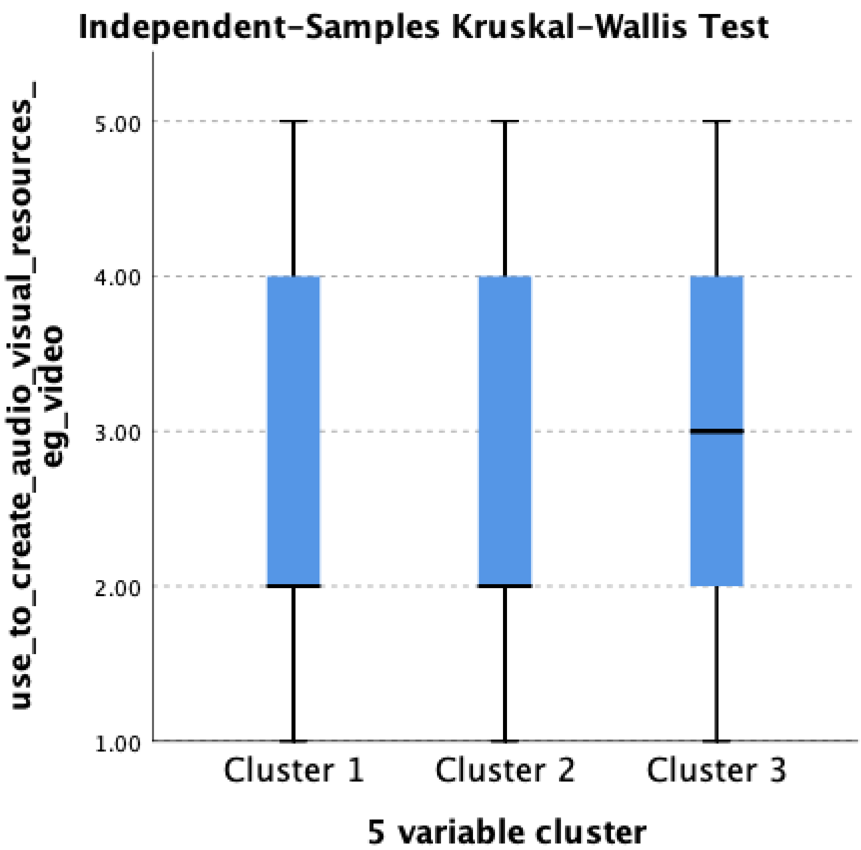
Use to create audio visual resources e.g., video across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	2.733[a,b]
Degree of Freedom	2
Asymptotic Sig.(2-sided test)	.255

a. The test statistic is adjusted for ties.

b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

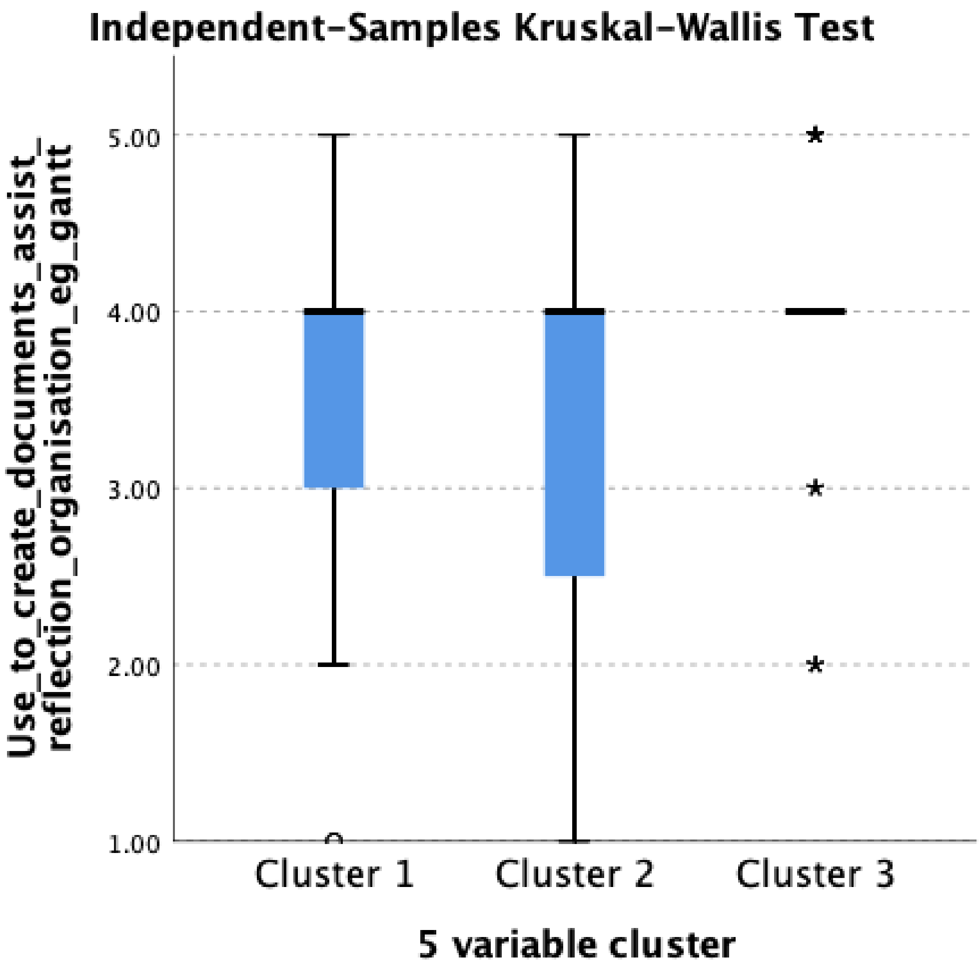


Use to create documents assist reflection organisation e.g., Gantt across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	7.779[a]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.020

a. The test statistic is adjusted for ties.



Pairwise Comparisons of 5 variable cluster

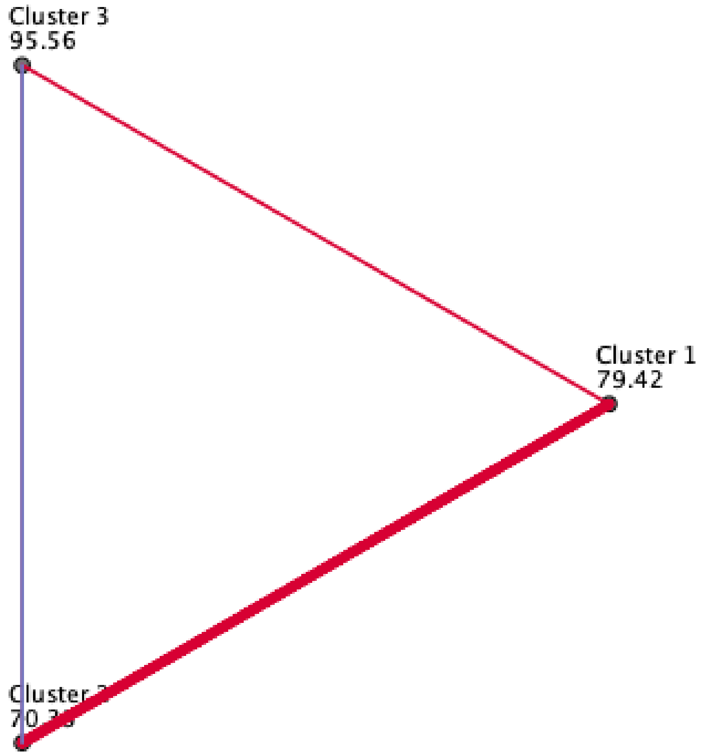
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statis-tic	Sig.	Adj. Sig.[a]
Cluster 2-Cluster 1	9.065	7.601	1.193	.233	.699
Cluster 2-Cluster 3	-25.212	9.062	-2.782	.005	.016
Cluster 1-Cluster 3	-16.148	9.486	-1.702	.089	.266

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Pairwise Comparisons of 5 variable cluster



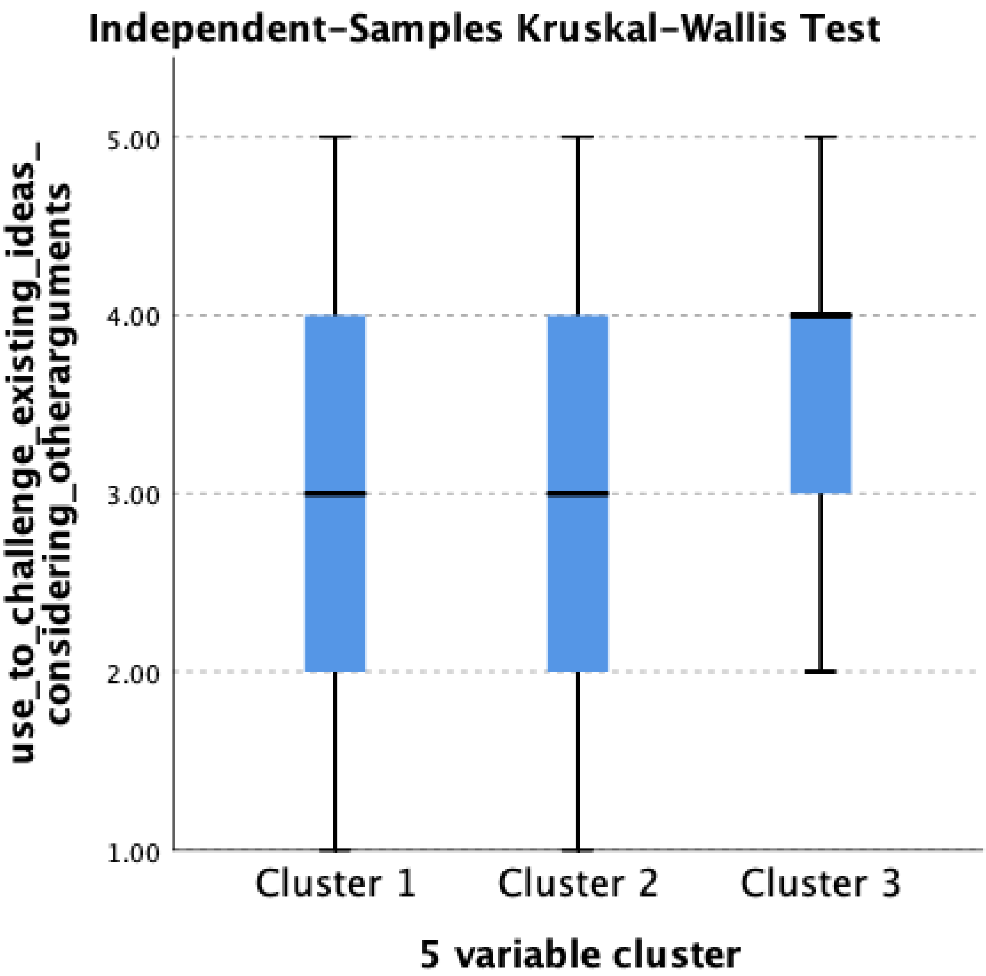
Each node shows the sample average rank of 5 variable cluster.

Use to challenge existing ideas considering other arguments across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	13.392[a]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.001

a. The test statistic is adjusted for ties.



Pairwise Comparisons of 5 variable cluster

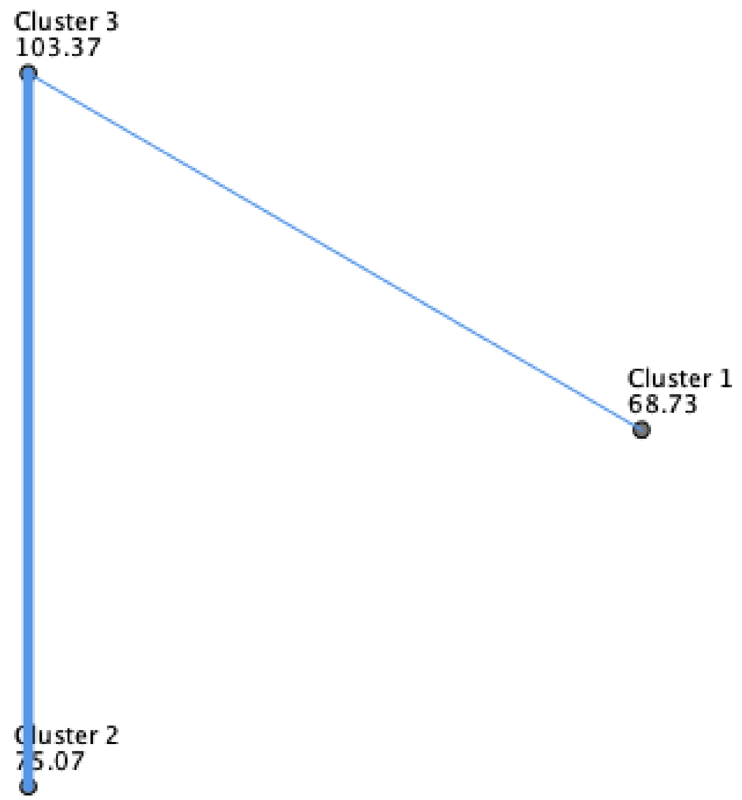
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Cluster 1-Cluster 2	-6.339	7.827	-.810	.418	1.000
Cluster 1-Cluster 3	-34.639	9.768	-3.546	.000	.001
Cluster 2-Cluster 3	-28.301	9.331	-3.033	.002	.007

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Pairwise Comparisons of 5 variable cluster



Each node shows the sample average rank of 5 variable cluster.

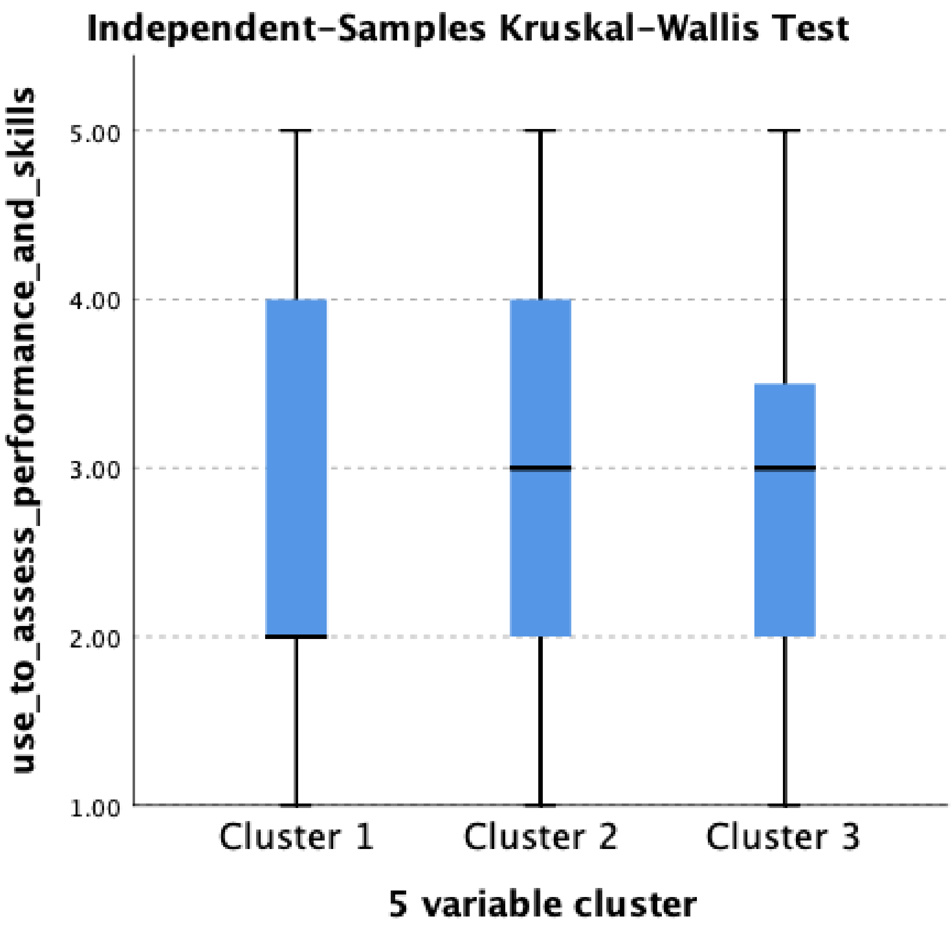
Use to assess performance and skills across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	1.041[a,b]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.594

a. The test statistic is adjusted for ties.

b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

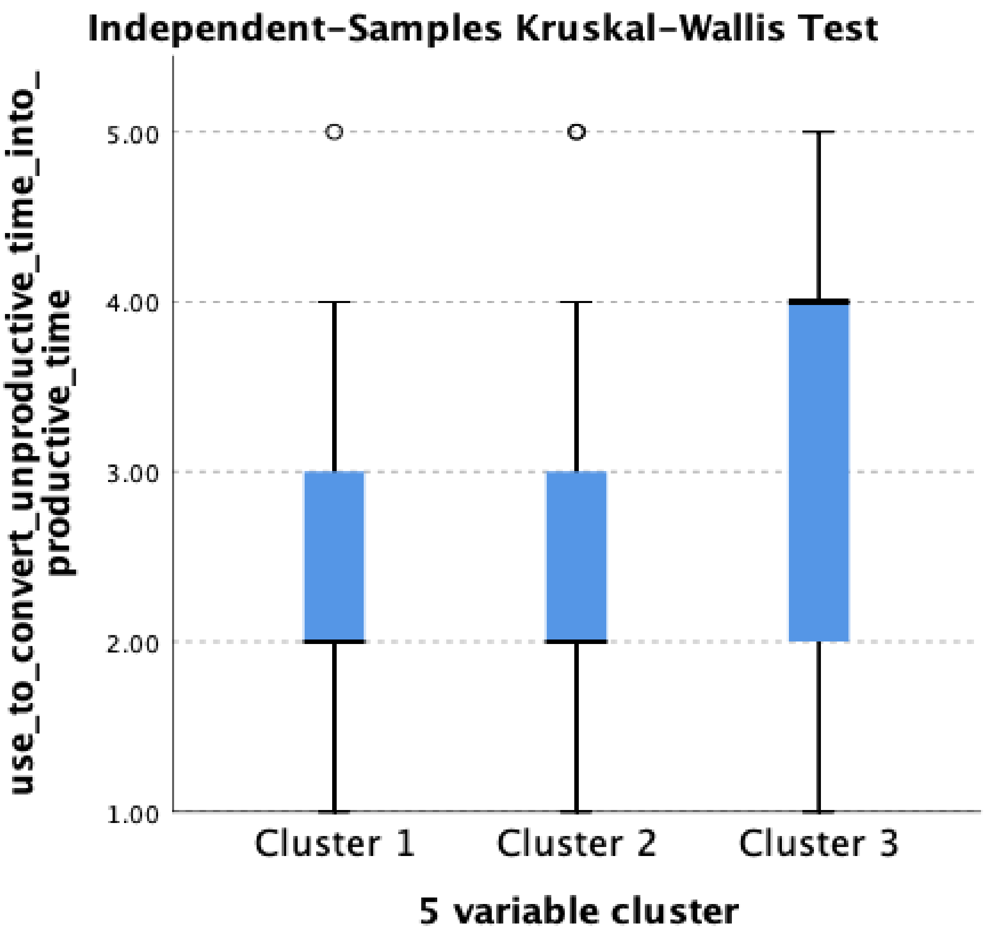


Use to convert unproductive time into productive time across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	7.309[a]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.026

a. The test statistic is adjusted for ties.



Pairwise Comparisons of 5 variable cluster

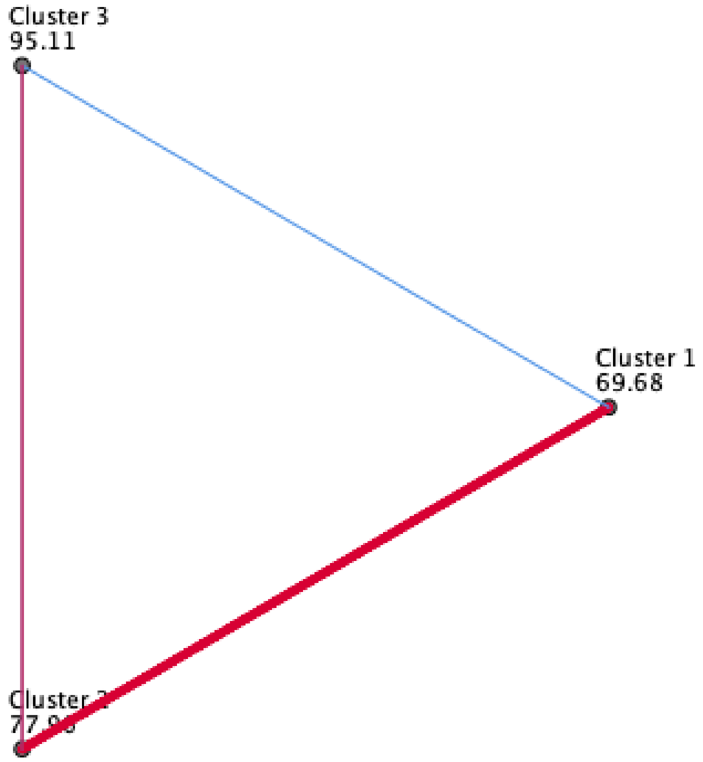
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statis-tic	Sig.	Adj. Sig.[a]
Cluster 1-Cluster 2	-8.282	7.551	-1.097	.273	.818
Cluster 1-Cluster 3	-25.437	9.423	-2.699	.007	.021
Cluster 2-Cluster 3	-17.155	9.002	-1.906	.057	.170

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Pairwise Comparisons of 5 variable cluster



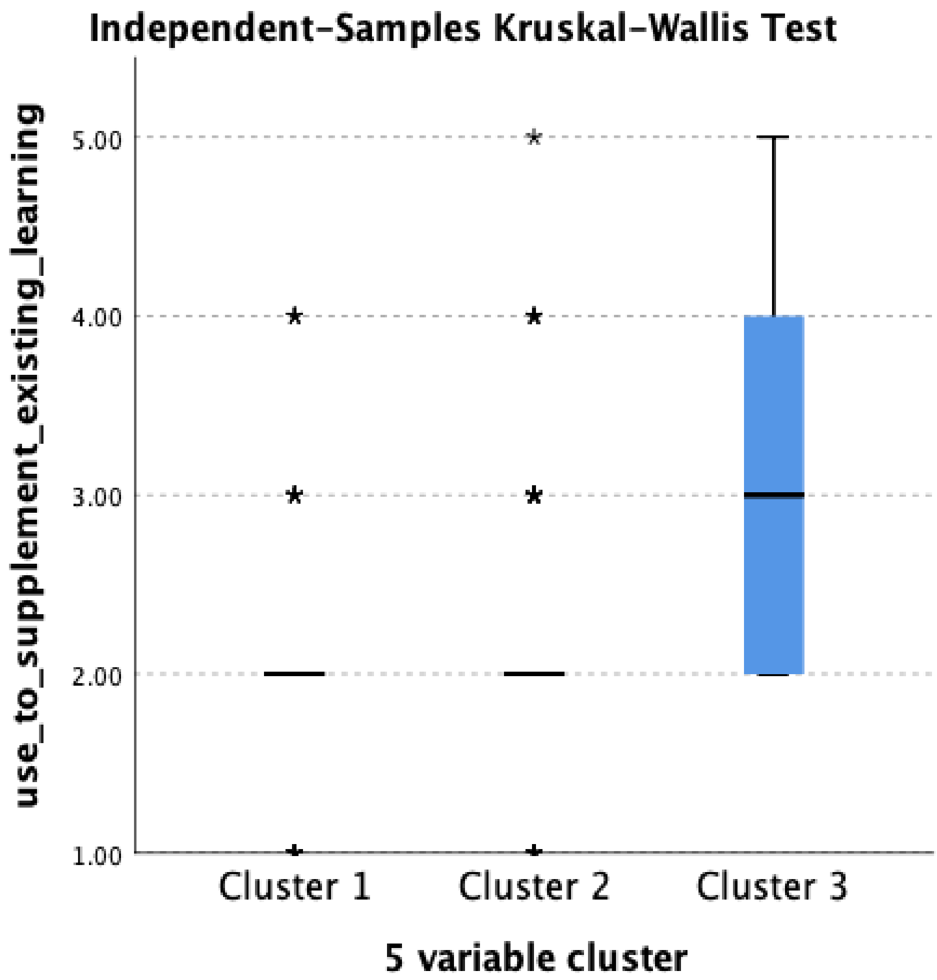
Each node shows the sample average rank of 5 variable cluster.

Use to supplement existing learning across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	21.380[a]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.000

a. The test statistic is adjusted for ties.



Pairwise Comparisons of 5 variable cluster

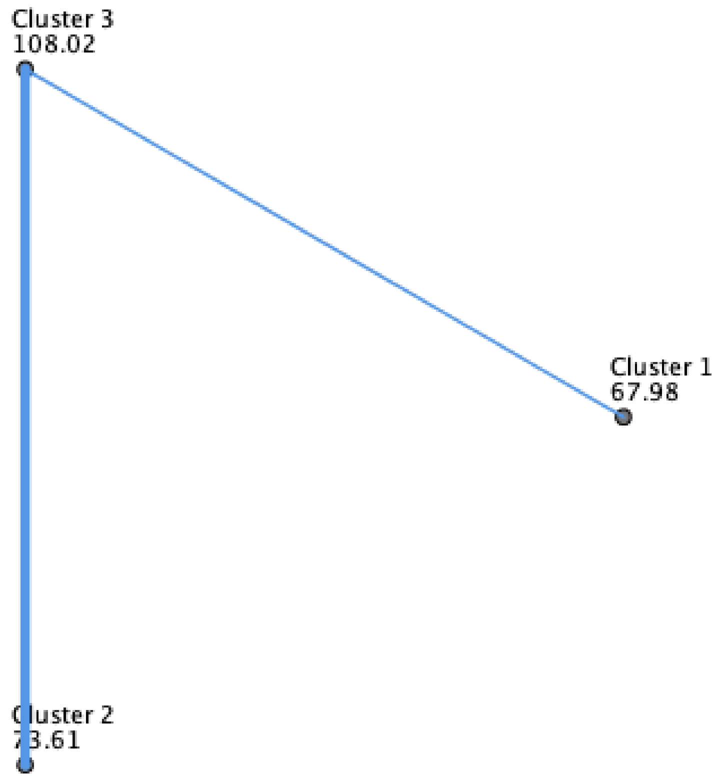
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statis-tic	Sig.	Adj. Sig.[a]
Cluster 1-Cluster 2	-5.631	7.272	-.774	.439	1.000
Cluster 1-Cluster 3	-40.035	9.075	-4.411	.000	.000
Cluster 2-Cluster 3	-34.403	8.670	-3.968	.000	.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Pairwise Comparisons of 5 variable cluster



Each node shows the sample average rank of 5 variable cluster.

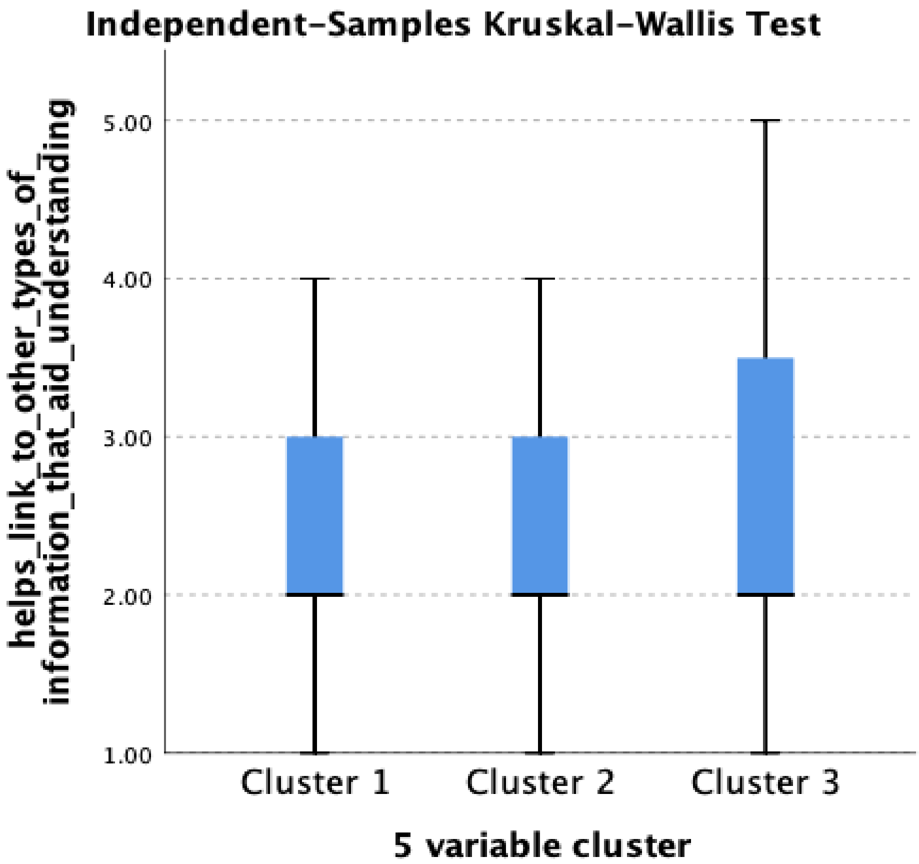
Helps link to other types of information that aid understanding across 5 variable cluster.

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	2.513[a,b]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.285

a. The test statistic is adjusted for ties.

b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

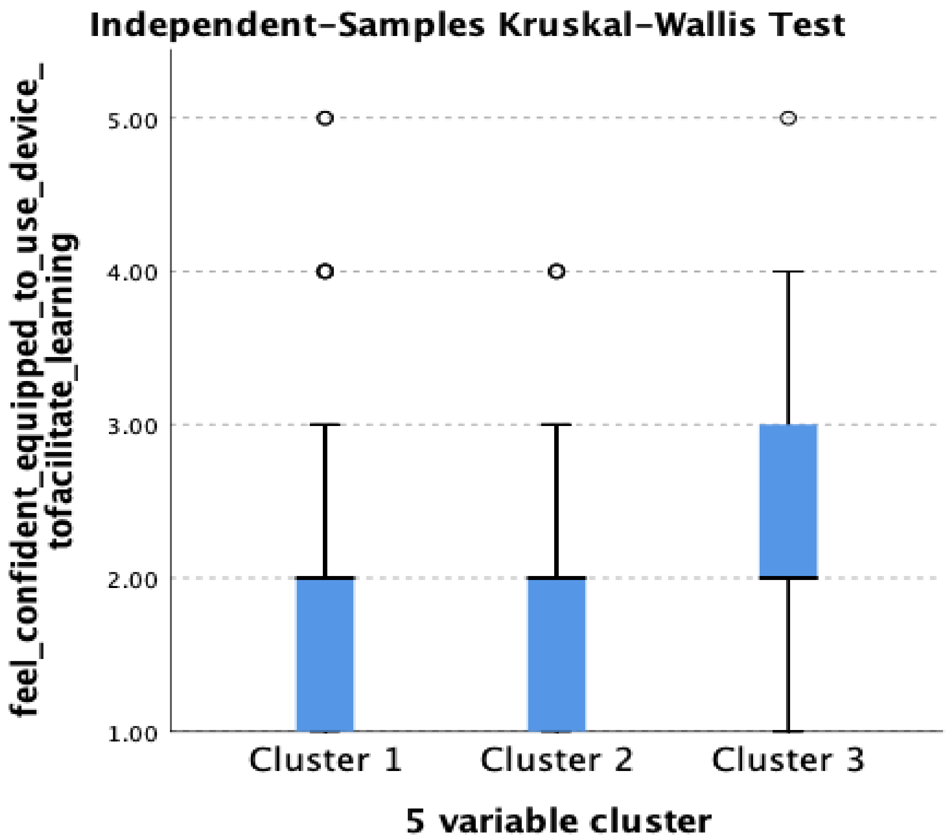


Feel confident equipped to use device to facilitate learning across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	7.693[a]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.021

a. The test statistic is adjusted for ties.



Pairwise Comparisons of 5 variable cluster

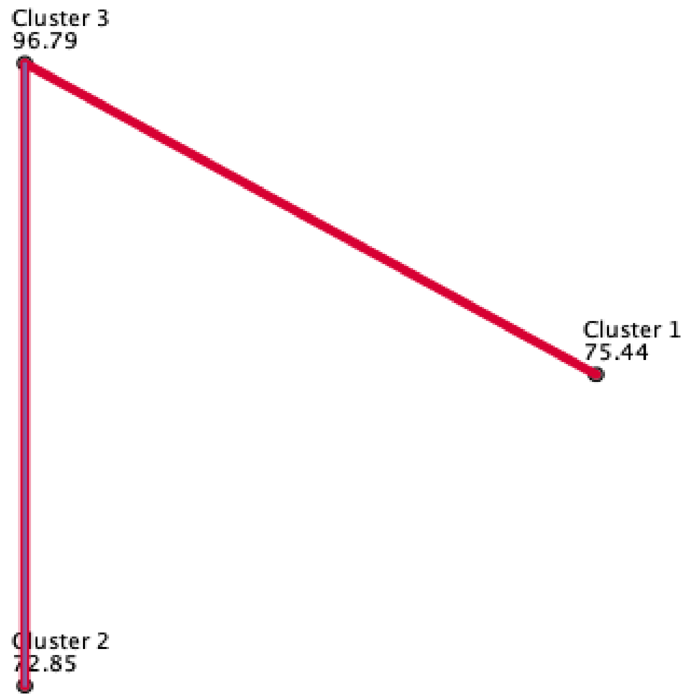
Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statis-tic	Sig.	Adj. Sig.[a]
Cluster 2-Cluster 1	2.590	7.465	.347	.729	1.000
Cluster 2-Cluster 3	-23.945	8.900	-2.690	.007	.021
Cluster 1-Cluster 3	-21.355	9.316	-2.292	.022	.066

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

Pairwise Comparisons of 5 variable cluster



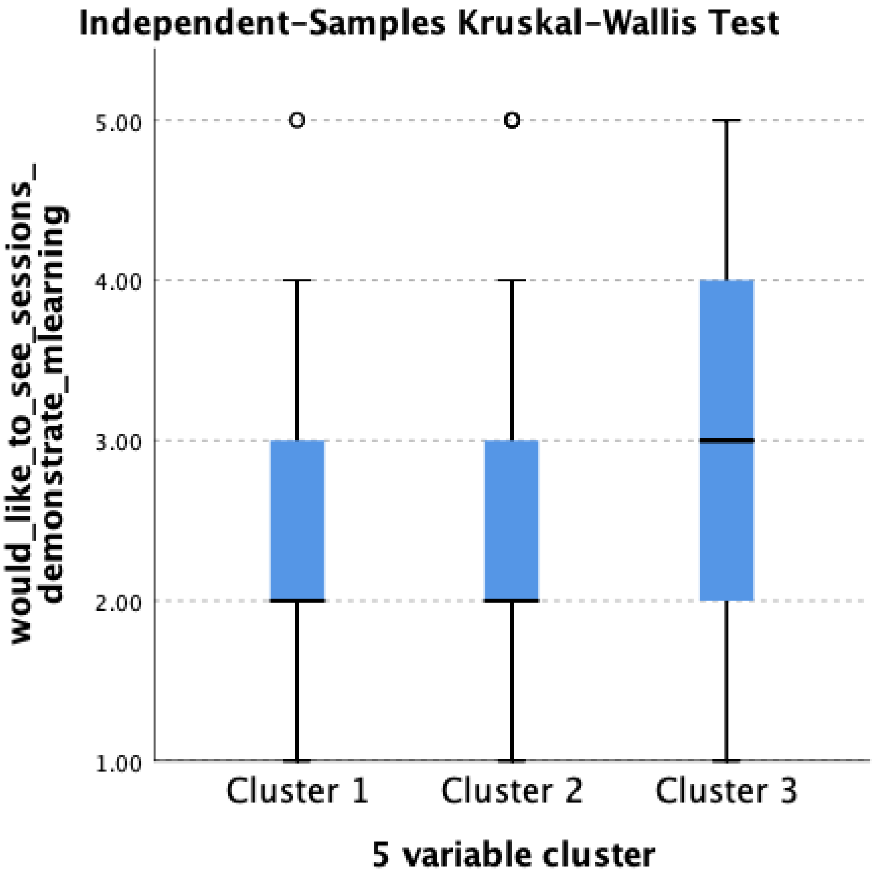
Each node shows the sample average rank of 5 variable cluster.

Would like to see sessions demonstrate mlearning across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	8.118[a]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.017

a. The test statistic is adjusted for ties.



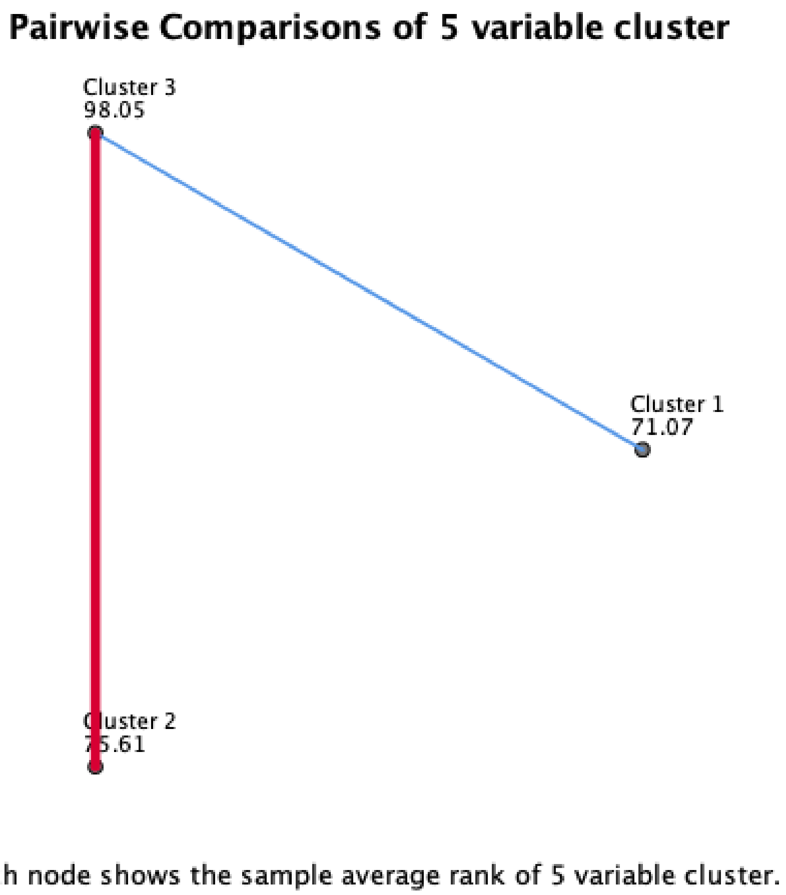
Pairwise Comparisons of 5 variable cluster

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj. Sig.[a]
Cluster 1-Cluster 2	-4.539	7.869	-.577	.564	1.000
Cluster 1-Cluster 3	-26.974	9.820	-2.747	.006	.018
Cluster 2-Cluster 3	-22.436	9.381	-2.392	.017	.050

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.

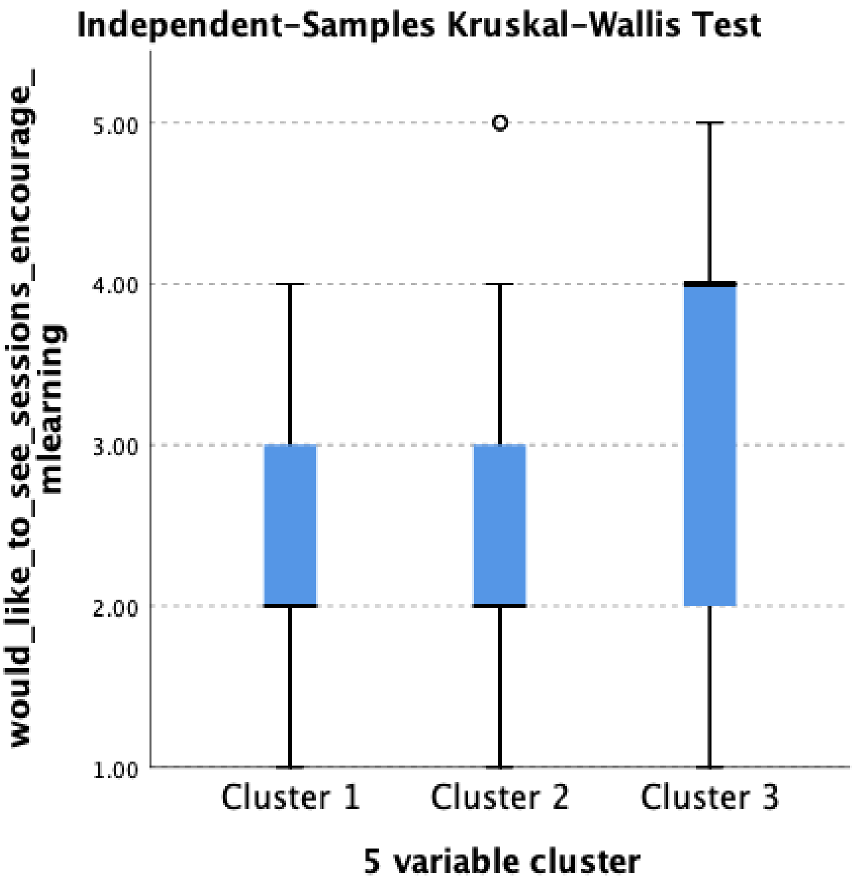


Would like to see sessions encourage mlearning across 5 variable cluster

Independent-Samples Kruskal-Wallis Test Summary

Total N	156
Test Statistic	15.331[a]
Degree of Freedom	2
Asymptotic Sig. (2-sided test)	.000

a. The test statistic is adjusted for ties.



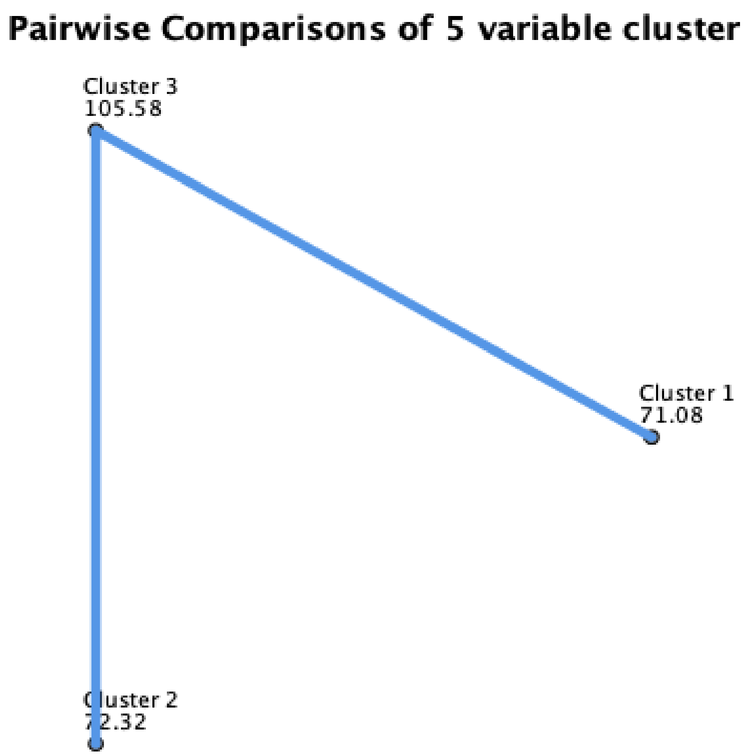
Pairwise Comparisons of 5 variable cluster

Sample 1-Sample 2	Test Statistic	Std. Error	Std. Test Statis-tic	Sig.	Adj. Sig.[a]
Cluster 1-Cluster 2	-1.234	7.774	-.159	.874	1.000
Cluster 1-Cluster 3	-34.497	9.702	-3.556	.000	.001
Cluster 2-Cluster 3	-33.264	9.269	-3.589	.000	.001

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.

Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

a. Significance values have been adjusted by the Bonferroni correction for multiple tests.



Each node shows the sample average rank of 5 variable cluster.

Back to Top of Document