# Technology and Technology-Enhanced Learning: Age Differences in Use and Attitudes

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## ABSTRACT

Mature students are stereotypically thought to be more anxious about technology and technology-enhanced learning than younger students, and are thought, as a result, to tend to avoid using technology. This is a potential problem in modern higher education, where the number of mature students in classes is increasing and new learning technologies are widely used. Previous studies examining the attitudes of mature students to technology no longer reflect either contemporary student age profiles, or the current technological landscape. This research project conducts a timely exploration of how attitudes to and use of technology and technology-enhanced learning differ across different age groups of students in a UK university, and the factors that affect these. A new diagnostic instrument, the Technology Attitudes Questionnaire, was developed to investigate differences in attitude and usage, and interviews were conducted to explore the underlying reasons for these differences. It was found that students of different ages do not have drastically differing attitudes towards technology-enhanced learning, but they do use it differently. Mature students tend to use fewer technologies less frequently than younger students, but have used them for a longer period over their lives. A thematic analysis shows that perceived knowledge level, familiarity, purpose, and design are among the main factors that affect students' attitudes and confidence with technology-enhanced learning. This project aims to contribute to the wider field of knowledge about technology use and attitudes in higher education, particularly for the modern cohort. The findings from this study can be used to inform how educators design age-inclusive learning environments and use technology and technology-enhanced learning throughout their programmes.

# Contents

## Declaration

I, the author, confirm that the thesis is my own work. I am aware of the University's Guidance on the Use of Unfair Means (www.sheffield.ac.uk/ssid/unfair-means). This work has not been previously presented for an award at this, or any other, university.

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## List of Abbreviations

| | |
|---|---|
| A-level | General Certificate of Education Advanced level |
| ANOVA | Analysis of variance |
| ANSYS | Analysis System |
| ATCQ | Attitudes Towards Computers Questionnaire |
| BAC | Books and Computers Questionnaire |
| BT | British Telecom |
| BTEC | Business and Technology Education Council |
| CAQ | Computer Attitude Questionnaire |
| COVID-19 | Coronavirus disease 2019 |
| DFEE | Department for Education and Employment |
| EFA | Exploratory factor analysis |
| EM | Electromagnetic |
| FE | Further education |
| GCSE | General Certificate of Secondary Education |
| HE | Higher education |
| HEFCE | Higher Education Funding Council for England |
| HSD | Honestly significant difference |
| IBM | International Business Machines |
| ICT | Information and communications technology |
| IT | Information technology |
| ITASH | Information Technology Attitudes Scale for Health |
| JSTOR | Journal Storage |
| KMO | Kaiser-Meyer-Olkin |
| LEA | Local Education Authority |
| MP3 | MPEG audio layer-3 |
| MTAS | Mathematics and Technology Attitudes Scale |
| NAS | Network Attached Storage |
| O-level | General Certificate of Education Ordinary level |
| OCE | Objective computer experience |
| OFFA | Office for Fair Access |

| | |
|---|---|
| OS | Operating system |
| OU | Open University |
| PC | Personal computer |
| PCA | Principal components analysis |
| PhD | Doctor of Philosophy |
| PGCE | Postgraduate Certificate in Education |
| Q-Q | Quantile-quantile |
| RQ | Research question |
| Satnav | Satellite navigation system |
| SCE | Subjective computer experience |
| SPSS | Statistical Product and Service Solutions |
| TAM | Technology Acceptance Model |
| TAM2 | Technology Acceptance Model 2 |
| TAQ | Technology Attitudes Questionnaire |
| TCI/IP | Transmission Control Protocol and the Internet Protocol |
| TED | Technology, Entertainment, Design |
| TEFL | Teach English as a Foreign Language |
| TEL | Technology-enhanced learning |
| THE | Times Higher Education |
| TLE | Technological learning environment |
| TV | Television |
| UCAS | Universities and Colleges Admissions Service |
| UK | United Kingdom |
| UNESCO | United Nations Educational, Scientific and Cultural Organisation |
| USA | United States of America |
| VAK | Visual, auditory and kinaesthetic |
| VLE | Virtual learning environment |
| WEA | Workers' Educational Association |
| WWI | World War I |

## List of Appendices

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# 1 Introduction

> I've come up with a set of rules that describe our reactions to technologies:
> 1. Anything that is in the world when you're born is normal and ordinary and is just a natural part of the way the world works.
> 2. Anything that's invented between when you're fifteen and thirty-five is new and exciting and revolutionary and you can probably get a career in it.
> 3. Anything invented after you're thirty-five is against the natural order of things.
>
> - Douglas Adams, The Salmon of Doubt, 2003, p. 95.

In this study, I have conducted a timely exploration of how attitudes to technology, learning technologies, and technology-enhanced learning (TEL) differ across different age groups in higher education (HE), with a focus on mature students. This was done using a new instrument designed for purpose. This study also explores which factors affect students' attitudes and technology confidence. These findings inform a discussion of the implications for the design of age-inclusive learning environments.

The 'traditional' higher education student is regarded as a direct school leaver with standard qualifications, white, able-bodied, financially independent and unencumbered, from the dominant socio-economic group (Egerton & Halsey, 1993; Leathwood & O'Connell, 2003; Schuetze, 2014). In the past the traditional student was also regarded as male, however in the mid-90s, the number of women in HE surpassed men, and has remained that way since, with 9.5% more women accepted onto undergraduate courses than men in 2019 (Dolch & Zawacki-Richter, 2018; UCAS, 2020b; I. Walker & Zhu, 2008).

Over several decades the number of non-traditional students studying at university has grown (Nation & Evans, 1996; Wakeford, 1993). In contrast with the 'traditional' student who is associated with the characteristics above, the term 'non-traditional' covers a wide range of other students who don't fall under the 'traditional' label. I have chosen to focus this study on one aspect of the non-traditional student – the mature student. Although being 'mature' is one characteristic of many that a student may possess, this characteristic is of particular interest to me.

## 1.1 Research Topic and Justification

This section explains how the topics of mature and other non-traditional students, and the use of technology and technology-enhanced learning, grew to be of interest to me throughout my life.

I grew up in a small town in the rural farmer-county of Norfolk. I attended the primary school in my hometown, and later the associated state secondary school, just a few hundred yards further along the road.

My mother was a science technician at the local secondary school, and my father was an able seaman in the merchant navy. I was an only child, aside from much older half-siblings from my father's first marriage. My parents were largely working class. My father left school at 14 with no qualifications, after years of sporadic attendance due to having to look after younger siblings. He worked away at sea for most of his life. My mother completed her secondary schooling and went into work.

I was a very high achieving pupil. I was top of my class throughout primary school, and always in the top three in secondary school. Although my parents couldn't afford to let me do all the extracurricular activities I might have wanted, I chose to learn the violin (much to my father's bemusement) and attend the annual science Christmas Lectures in London. My friendship group was a mix of middle-class and working-class pupils, but as we broadly shared the same interests and were well-behaved in class, we formed close friendships.

My parents were always extremely supportive of my academic work, and encouraged me to do the best that I could. I never felt that my parents *expected* me to go to sixth form and university, as they tried very hard not to put any pressure on me academically. However they always talked very positively about the next steps in my education, so when I began to take it for granted I would attend sixth form and then university, it never occurred to me that they would be anything but supportive. It therefore came as a shock to me when my best friend, an extraordinary artist also from a working class family, expressed a desire to go to sixth form to her parents, and they swiftly and firmly tried to talk her out of it. This horrified me, and was my first indication that working class families might feel threatened by their friends and family becoming educated. It was also the first indication I had that continuing into further and higher education was something that could be determined not only by your grades, but by your position in life.

I was the first person in my entire family to go to university, and attended Durham University, which in my experience, seemed full of middle-class, 'posh' students. This felt rather lonely at times, as I didn't quite fit in as easily as everyone else appeared to. It took me several weeks of listening to wealthy classmates talk about their gap years and horses to realise that my socioeconomic status may have been the reason that I found it difficult to connect. This contributed to university being a difficult time for me, combined with the very challenging course material of a chemistry degree. However, I finished my degree, then completed a PGCE and subsequent Masters in Education. When I started my PhD at the age of 25, I officially became a 'mature student', as defined by my institution, and Lincoln and Tindle (2000). I still consider myself of working class background, but with middle class experiences after attending university, which is commensurate with many working class academics (Brook & Michell, 2012).

My background has contributed strongly to my research interests. I now teach foundation-level chemistry and maths to other mature students in a university, so have regular contact with students from a variety of different educational backgrounds and socioeconomic statuses. I have seen and experienced how difficult it can be for students to progress into higher education from working class backgrounds, through their own expectations and attitudes, and those of their families. Mature students in particular are more likely to be from working class families (Baxter & Britton, 2001; Egerton & Halsey, 1993), and find it especially difficult to move away from their familiar lives in order to progress themselves and their careers (Baxter & Britton, 2001).

My own experiences of learning with technology as a child were limited. My primary school had a single computer in each classroom, and the only time we were allowed to use it was to design a wallpaper in Microsoft Paint for a design and technology project. My secondary school was somewhat better, with two computer rooms, each containing about 30 computers. These were mainly used for dismal information technology lessons, teaching us how to change margins in Word, alter the background colour of slides in Powerpoint, and how to input simple formulae into Excel. Despite these unappealing lessons, the computer rooms were open at break and lunch times for students to do homework or play Flash games, and I spent most lunchtimes there with my friends. Throughout my secondary school and sixth form schooling, computer use was usually optional. Despite this, I became confident, competent and comfortable using computer-based technology.

When I got to university, weekly lab reports were the only computer-based work required. However, this was more difficult. We were not given classes in computer use, so had to figure out how to use Excel and Word at a relatively high level for ourselves; despite my familiarity with computers, this was a difficult task, as some analysis techniques such as regression required Excel add-ins that were not provided as standard. I therefore sympathised strongly with students on my course who were less technology-literate than I was.

The department I currently work in requires all students to be able to use email and Blackboard proficiently on a regular basis, and my maths course asks students to become familiar with Excel and word-processing programs. This is not unusual for the wider institution, which has been pushing the use of learning technologies and TEL over the years, and particularly and necessarily during the recent COVID-19 pandemic. However, in my experience, many mature students struggle with using technology such as computers, even for basic functions such as email. Even those who seem competent with computers may exhibit signs of discomfort when having to use them in an academic setting. This observation sparked my curiosity about how mature students engage with technology and technology-enhanced learning experiences more generally. I wanted to explore and develop a better understanding of factors influencing the use of technology and TEL in the mature student population compared with younger students. I had formed an impression that, generally, it tends to be the older mature students of age 40 and above who struggle most with the idea of using technology, so I became interested in finding out if there are any differences in the attitudes to, and comfort with using, technology and TEL between mature students of different ages. I believe it will be important in the future to consider mature students specifically in the creation and development of TEL environments and technological resources. This will enable the design of age-inclusive learning environments, and may allow a subpopulation who have found learning challenging to more successfully access HE.

## 1.2 Context of the Study

### 1.2.1 Lifelong Learning

This section compiles a brief historical survey to explain how lifelong learning and adult education has developed in the UK.

Lifelong learning has no widely-accepted definition (Griffin, 2006; Sharples, 2000). It is often interpreted, particularly by policy-makers, as a form of training for the workforce (Faure et al., 1972; J. Field, 2000; Sharples, 2000). Sharples (2000, p. 178) takes a broader view, defining lifelong learning as "an extended and holistic process", one that allows adults to develop their own skills and understanding of a wider series of topics than their job. In this thesis I will follow Baxter and Britton (2001) in defining lifelong learning as any form of education, whether formal or informal, vocational or academic, pursued by adults.

Adult education came to the fore shortly after the end of World War I (WWI) in an effort for adults to escape the economic deprivation of the period (Grace, 2013). The World Association for Adult Education was founded in 1919, with a UK-specific version, the British Institute of Adult Education, being founded in 1921 (Kelly, 1950). The pivotal Final Report by the Adult Education Committee (British Ministry of Reconstruction, 1919) was published in 1919, setting out an education response and transition needed for the public to move past the aftermath of WWI. This report recommended that "the provision of a liberal education for adult students should be regarded as a normal and necessary part of their function" (British Ministry of Reconstruction, 1919, p. 169). The Education Act of 1944 (*Education Act 1994,* 1944) was designed to provide for adult learners, but due to a lack of coordination between Local Education Authorities (LEAs), universities, the Workers' Educational Association and other involved bodies, the result was largely unsuccessful (Kelly, 1950).

In 1973, the Russell Committee issued a detailed report on Adult Education in England and Wales, aiming to review adult education; the report also made recommendations for provision of an educational system that continues throughout one's life (H. R. Jones, 1974; Russell Committee, 1973). The report stated that provision had been lacking, with 75% of adults never encountering formal adult education. Armed with a vision of a broad, comprehensive, and flexible adult education service, the Russell Committee urged this service to help 'late developers', as this would benefit the individual whilst also positively affecting quality of life within a democratic society. The key recommendations of the report suggested methods to double both the financial provision and the number of adult students over a five-year timeframe. It also encouraged the continued development of the relationship between voluntary and statutory bodies in order to promote adult education (Russell Committee, 1973). In a critical summary of the Russell Report, Jones (1974) suggests that the recommendations of the report were deliberately kept modest and easily achievable, so that the government might more easily accept the proposals. As feared, the report was forgotten about in a withdrawal of funding from public spending.

Due to the dearth of successful policies and government action prior to the 1980s, mature students were a lot less common than the present day, and constituted only a small proportion of university applicants (Nation & Evans, 1996). There were a series of initiatives for distance-learning courses (Bell & Tight, 1993), and the Open University (OU) became the first (self-proclaimed) successful distance-learning university. It opened to students in 1971 with an open admissions policy (*The OU Story*, 2014). This meant it was among the first to cater for mainly non-traditional students, in a climate of traditional education.

A UNESCO report in 1972 that promoted lifelong learning and adult education, criticised psychopedagogic research for not studying adult learning in the same systematic manner as children (Faure et al., 1972). It suggested that educational divides between school and out-of-school, formal and informal, child and adult education are gradually, and rightly, fading. The report claimed that the lifelong education movement had developed strength over the previous ten years, and needed to be extended and supported in order to become a deliberate choice for policy makers and the public to follow (Faure et al., 1972).

In the 1980s this increased support for non-traditional students to access university started to come to fruition (Parry & Wake, 1990). In 1998, a DFEE Green Paper report was wholly dedicated to lifelong learning (*The Learning Age: A Renaissance for a New Britain*, 1998). It set out a number of proposals to further extend opportunities, funding, and support for Further Education, HE, adult education and community education. Although these policies have been criticised as weak and confusing, it has also been acknowledged that they were the result of significant shifts in the way education was perceived, and there was hope about how these changes might affect the educational landscape (J. Field, 2000).

Since 2000, the wish to increase adult participation in HE has become a widely-discussed issue in European education policy, with many countries developing their own policies (Broek & Hake, 2012). Countries have different lifelong learning strategies depending on their historic-ideological development, welfare system, economic situation, and government perspective. The UK strategically targets adults as part of a widening participation agenda for HE. Incentives have been introduced to induce institutions to target adults across the European Union. Sweden in particular has a long-standing, successful sector specialising in adult education (Broek & Hake, 2012). Nor is Europe the only continent to have developed lifelong learning strategies. The movement is international, with countries such as Singapore (Government of Singapore, 2015) and Malaysia (Ministry of Higher Education Malaysia, 2011) also identifying lifelong learning as an area of priority.

Lifelong learning has gradually emerged as a national and international subject of interest over the last century, with particular interest in the last twenty years (Boeren, 2009). It may be no coincidence that this coincides with another emerging field in education research during this time – technology-enhanced learning.

### 1.2.2 Technology and Technology-Enhanced Learning

Technology-enhanced learning is a term that originated in the late 1980s and early 1990s (Pea, 1994; Wohlert, 1989), and is often used to describe the process of learning using technology (Kirkwood & Price, 2014). However, technology-enhanced learning itself has no clear start point (Westera, 2010). This is due to the ever-evolving concept of technology itself. Technology can be defined in a number of different ways, from being a body of knowledge, the application of skills, or the tools we use (Aunger, 2010). For the purposes of this thesis, I will use the definition of 'technologies' or 'learning-enhancing technologies' as the tools we use, and 'technology-enhanced learning' as the process of learning using technology.

In the present day, we think of technology as being computer-based, whether a desktop computer, laptop, mobile telephone, e-reader or microwave. The iPad, invented in 2010 (Randles, 2013), would undoubtedly be considered recent technology. Mobile learning material, which originated in the 2000s (Ally, 2009), also falls into this bracket. The personal computer has been a part of our lives since the 1980s (Campbell-Kelly, Aspray, Ensmenger & Yost, 2013), and is most definitely thought of as technology.

The first pocket calculator came into being in 1947 (Stoll, 2004). Only six years before that, in 1941, the ballpoint pen was invented (Biro, 1941). When new, these were technological advances; indeed, we are still using both 80 years later in our classrooms. Surely, then, these items must be included in our umbrella term of technology.

Now consider the pencil. Again, this is an item we use every day, and is used a lot in classrooms. The earliest pencil found was from 1722, a technological advancement from the graphite sticks or styluses used previously (Voice, 1949). The pencil is therefore also technology. What then of the blackboard, originating in German classrooms in the 1600s (Day, 1967)? This must also be technology. Westera (2010) suggests that cavemen using chemically-extracted coloured pigments were also using what we must call technology. A timeline of a selection of learning-enhancing technologies is presented in Figure 1.2.1. By necessity, this is in no way exhaustive, but it is a rather interesting look into technology's long past.

**Figure 1.2.1**
*Timeline of (some) learning-enhancing technologies*

| | |
|---|---|
| 1440s | •Printing press<br>•(Kapr, 1996) |
| 1600s | •Blackboards<br>•(Day, 1987) |
| 1722 | •Pencil<br>•(Voice, 1949) |
| 1926 | •Pressey testing machine<br>•(Pressey, 1926) |
| 1941 | •Ballpoint pen<br>•(Biro, 1941) |
| 1947 | •Pocket calculator<br>•(Stoll, 2004) |
| 1960 | •Skinner teaching machine<br>•(Skinner, 1960) |
| 1980s | •Personal computer<br>•(Campbell-Kelly, Apray, Ensmenger & Yost, 2013) |
| 1984 | •CD ROM drive<br>•(Stan, 2013; Wertz, 1986) |
| 1990 | •Interactive whiteboard<br>•(Tang & Minneman, 1990) |
| 1990s | •Wireless technology<br>•(Tuch, 1993) |
| 1995 | •Commercialised internet<br>•(NII 2000 Steering Committee et al., 1998) |
| 2000s | •Mobile learning<br>•(Ally, 2009) |
| 2005 | •YouTube<br>•(Burgess & Green, 2013) |
| 2010 | •iPad<br>•(Randles, 2013) |
| 2012 | •MOOCs<br>•(Baggaley, 2013) |

## 1.3 Research Questions

The aims of this project were to explore the differences in use and attitudes towards technology and TEL between mature and non-mature higher-education (HE) students. The implications for age-inclusive resource and learning environment design are considered. To this end, my research questions are:

1) How do usage and attitudes to technology and technology-enhanced learning in higher education differ for students of different age groups?

2) What factors affect students' use, attitudes and confidence with technology and TEL, and is there a difference between mature and non-mature students?

3) What are the implications for the design of age-inclusive learning environments in higher education?

These research questions were formulated from comparisons of my own experiences teaching mature students in HE and teaching secondary-age children. In general, the self-confidence of mature students appeared to me to be lower, and when asked to do work involving technology, they often became anxious and struggled to engage with given tasks, even when provided with detailed instructions. There seemed to be a relationship between age and technology avoidance. My observation of mature students interacting with computers and technology led me to question whether it was the actual skills of the students that were different from younger students, or whether the problems arose due to a difference in attitudes and comfort with technology and TEL. This led to the initial development of research question one, looking at the use and attitudes to technology and TEL of students of different ages.

My teaching conversations with mature students led me to consider what other factors might also affect attitudes to technology and TEL, both positively and negatively. One of the main points that emerged was that, generally, students who used computers and other technologies regularly at home and at work tended to be more comfortable using them in classes. There was, however, one interesting exception to this. One of my students, when working on a reception desk in her job, used the work computer frequently, but was one of my least confident, most technology-fearing tutees. When discussing this with her, she told me that the computer at work used only one specific piece of software which bore no resemblance to the Windows 7 operating system we were using in class. Consequently, although she was comfortable using that one piece of software, anything unfamiliar was frightening to her. Prompted by these conversations and thoughts, I posed research question two to determine what factors affect students' use, attitudes, and confidence with technology and TEL.

My third research question addresses the practical use of these findings, asking what the implications are for real-world resource and learning-environment design. The results from this research question will be of use to educators who are designing technology-based resources for use in HE classrooms that contain mature students.

Table 1.3.1 shows how I have addressed each research question in turn. Chapter 3, Methodology and Methods, goes into further detail.

**Table 1.3.1**

*Sources used for addressing each research question (RQ)*

| | Literature review | Questionnaire | Interviews | Own experience |
|---|---|---|---|---|
| RQ 1 | ✔ | ✔ | ✔ | ✔ |
| RQ 2 | ✔ | | ✔ | ✔ |
| RQ 3 | ✔ | ✔ | ✔ | ✔ |

There is a gap in both research and practice for designing technology-based resources and technology-enhanced learning environments for mature students. The modern cohort is changing to include more and more non-traditional students, of which mature students are just one category. At the same time, universities are integrating technology throughout, and are pressuring tutors and lecturers to use it innovatively, particularly during the pivot to online teaching for COVID-19. In turn, all students are expected to engage successfully and rapidly with potentially-new technologies, irrespective of their level or background. This combination of a changing cohort and increase in technology usage presents challenges in designing learning activities and environments that are accessible to all. Since this study is located within a constructivist worldview, implications for the design of learning environments and resources should build from the histories and backgrounds of the students; not much is known about mature students' starting points in the use of learning technologies, and this study aims to inform on this. Additionally, this research project makes a wider contribution to the study of technology attitudes and use, an ongoing field that is continually changing with the evolving technology landscape and changing student cohort.

## 1.4 Structure of the Thesis

*Introduction*: This introduces my topic, and discusses the justification for my research topic, placing my research within the larger context and history of the area of study. It also introduces my research questions and their formulation.

*Literature Review*: The literature review considers the worldview that my project is situated within. It uses the theoretical and empirical literature published up until the present day in order to compile a comprehensive and current backdrop for this research study.

*Methodology and Methods*: This chapter discusses the knowledge framework upon which the study is built. The overall research design, participants and setting, ethics, and the creation of the Technology Attitudes Questionnaire (TAQ) and interview protocol and pilots are discussed. The methods of data analysis are explained and justified.

*Results and Analysis*: In this chapter I present my results. This includes quantitative results from the questionnaire, and qualitative results from a thematic analysis conducted on the interview data. A summary of the key interpretations is included.

*Discussion*: This chapter discusses the three research questions in turn, as well as further findings on types of knowledge. The limitations of the study, as well as suggestions for further work are explored.

*Conclusions:* Within this chapter I reflect on the significance and implications of my work.

*References*

*Appendices*: These include the ethics application, Technology Attitudes Questionnaire (TAQ), interview protocol, examples of transcription, and communications with participants.

# 2 Literature Review

This study aims to explore the attitudes, use, and experiences of mature students with technology and TEL, the factors that affect their use and attitudes, and what the implications are for designing age-inclusive learning resources and environments in higher education.

The relevant literature surrounding this subject is wide-ranging. My literature review focusses on four key themes. Firstly, I will explore the worldview that underpins the conceptualisation and implementation of this project. Secondly, I provide an overview of theories of learning. Thirdly, I discuss the concept of technology-enhanced learning, along with other learning technologies that are currently used in educational settings. Lastly, I explore the concept of a 'mature student', including their characteristics, learning preferences, and how they interact with technology in learning contexts.

## 2.1 Search Strategy

The literature search was carried out using the following databases: StarPlus (a University of Sheffield-specific search engine which in turn searched multiple major databases), Google Scholar, SAGE Journals, ScienceDirect and JSTOR. When I found a journal with a promising focus, or several useful articles from the same journal, I also did a search within the journal of interest. Relevant articles were saved within the program Zotero, which I used to organise my sources and also to make notes on the publications.

The search focussed on constructivism, technology and technology-enhanced learning, and mature students, and I initially did searches on the three separate topics. I began by limiting the literature to the years 1990 to the present, which at the time of beginning the literature search, was 2015. This time interval was chosen due to constructivism being more widely adopted around this time, with relatively little literature before this. Although these dates were chosen for the initial search, my snowball method did not restrict itself to the dates. If a likely paper was found outside these dates, it was not excluded. I also conducted an updated literature search in 2020, including papers up to and including that year.

I started with the term "constructivism", and did a basic literature search, gathering a range of articles. I then used the snowball method to expand my article pool and to determine whether there were any bodies of literature of similar subjects but using different terms. My supervisor recommended several works to me in addition to my own searches, for example, a specific book on constructivism by von Glasersfeld. I sourced these and again used the snowball method to find related articles and books through those. From this search and discussions with my supervisors, I determined some of the major authors connected with constructivism, namely von Glasersfeld and Piaget. These two surnames were used as subsequent search terms in order to find literature specifically about those authors' learning theories. I also searched for the term "constructivist" in case any texts had been missed from the previous search. From these five search terms, I read the titles and abstracts of the articles found and excluded biographical texts, or any texts that were not about the posited learning theories. I was aware of some works from my pre-PhD reading, such as Popper's works, and specific subject ideas, so I included these in my reading and review as well.

My technology-enhanced learning search used a variety of terms: "technology enhanced learning" (without the hyphen to allow for all possible variations), "TEL", "technology learning", "digital learning", "e-learning", and, to ensure coverage of an area I originally anticipated this PhD taking, "cloud learning". I also used search terms of "learning environment", since a lot of TEL infrastructures are labelled as learning environments in the literature. I read the titles and abstracts of the articles found, and excluded papers about technology as an academic subject, as well as about artificial intelligence learning systems. Overall, a number of articles were found, for which I then used the snowball method.

For my search relating to mature students, I used the search terms "mature", "adult" and "non-traditional", both on their own and combined with the terms "student", "learner" or "education". I also searched for "lifelong learning". Once again, I read the titles and abstracts, and excluded any articles that were not about mature students, or had a focus that did not fit with the issues I was exploring surrounding mature students. I also excluded any articles that were obviously out of date, for example those that discussed issues that were only present in the 70s and 80s. I then used the snowball method to find additional literature.

## 2.2 A Constructivist Worldview

Lincoln and Guba (1994, p. 107) define a 'worldview' as something that "defines, for its holder, the nature of the 'world,' the individual's place in it, and the range of possible relationships to that world and its parts". A researcher's worldview informs their ontological and epistomological beliefs, which in turn inform the methodological processes used within their research. By nature there are several different, competing worldviews that exist within educational research, of which constructivism is one (Y. S. Lincoln & Guba, 1994; Scaife, 2019b; Tashakkori & Teddlie, 2003). This research project is set within a constructivist worldview, and this section outlines the ontological and epistemological implications of this position.

Constructivism as a worldview is commonly believed to originate in its modern form from Piaget (Piaget, 1964, 1976; von Glasersfeld, 1995), although it can trace its roots back to Giambattista Vico in the 18$^{th}$ century (von Glasersfeld, 2008). The core tenet of constructivism is that an individual's knowledge is only constructed from their experiences, and thus each individual's reality is self-constructed and personal. It is important to specify that the term 'knowledge', as used within constructivism and therefore this thesis, is not defined as a copy of reality, which is a difference suggested by Piaget (Piaget, 1964). Von Glasersfeld, the father of 'radical constructivism', took Piaget's assertion to mean that there can be no justifiable claim of correspondence between one's cognitive structures and a universal ontological reality. An 'ontological reality' is a 'real world', external to the thinker, and separate from the mind. Even if there is such a thing as an ontological reality, constructivism does not presume to comment on it, as humans cannot directly access it, but can only experience it through their own knowledge frameworks and perception filters (von Glasersfeld, 1995). Von Glasersfeld comes to the conclusion that because we cannot know the truth of the real world, for a given phenomenon, there are an infinite number of viable theories that fit what we can perceive. A viable theory is one that has not yet been falsified, and is still worthy of consideration. The infinite number of theories is an often misunderstood point in criticisms of constructivism, as some authors (Confrey, 1990; Olssen, 1996) seem to interpret von Glasersfeld's words to mean that *all* theories of a given phenomenon are viable. However, my interpretation is that von Glasersfeld is saying that there are an infinite number of viable theories, out of an even bigger number of theories and opinions both currently viable and non-viable.

This reduction of possible theories is an idea that is consistent with Popper's ideas of falsification and falsifiability, and is, in fact, an interpretation that Popper himself expounds (Popper, 2005). Falsification is the idea that one can only prove theories incorrect, and that one can never prove a theory to be correct, nor should one try to (Curd & Cover, 1998). The ability of a theory to be falsified is the criterion of whether a theory is scientific or not (Popper, 2005). Although the layman may believe it is the job of a scientist to prove a theory, this is actually not the case. For every phenomenon, there is an infinite number of possible theories, as von Glasersfeld suggests. However, the scientist has not thought of all of these infinite theories, and therefore cannot prove that any single one is the cause of the phenomenon. However, the scientist can disprove, or reject, some of these theories. They do so, and if necessary, they revise the hypothesis and test it again. This iterative process is the scientific method.

Although the idea of an infinite number of viable theories may cause concern for some, von Glasersfeld's 'infinity' is indicative and theoretical. Following the elimination of non-viable theories (through the process of Popper's falsification), there are usually only a few viable theories remaining of which we know. There may be, technically, an infinite number, but since all but a few of them are unknown to humankind, we can disregard von Glasersfeld's infinity. To illustrate this, consider the electromagnetic (EM) spectrum, which is a continuum between the longest possible wavelength (the length of the universe) and the shortest possible wavelength (the Planck length) (Bakshi & Godse, 2009). In the visible spectrum portion, blue light is considered to have a wavelength of between 450 and 495 nm (Bruno & Svoronos, 2005). Due to the continuous nature of the EM spectrum, there is an infinite number of wavelengths between 450 and 495 nm, when we take values to more and more decimal places. However, despite this infinite number of intermediate wavelengths, we know that the colour we are examining is designated as blue.

It is not uncommon in the sciences for multiple, competing theories to run concurrently, competing with each other for scientific acceptance and dominance. Examples of this in the past that were resolved include Darwinism versus Lamarckism (Bowler, 1992), molecular-orbital theory versus valence-bond theory and the structure of benzene (Brush, 2015), and special relativity versus Lorentz-aether theory (Atkins, 1980), among many others. This phenomenon of plurality of theories is not a thing of the past, however; there are still highly-publicised battles between competing theories today, including dark matter versus modified gravity (Kunz & Sapone, 2007) and the standard model of particle physics versus string theory (Dine, 2007). We therefore continue to posit a large number of theories consistent with our experiential world that are viable, but over time, the non-viable theories are falsified, usually leaving one viable theory to persist, at least until more theories are posited.

It is not the stated goal of constructivism to seek correspondence between knowledge and an ontological reality, but it instead to seek parity and fit between new and prior experience and knowledge (Olssen, 1996). This internal 'experiential reality' does not seek or test itself against truth, but rather viability and self-consistency, an important distinction (von Glasersfeld, 1995). Popper (2005), as mentioned, defines 'empirical science' as a system that may be deemed scientific only if there is the capability of it being tested (and falsified) by experience; our idea of reality must reflect a *possible* world. This is compatible with the constructivist assertion that a world must be self-consistent, but that we can never know the truth of reality.

Although we can never directly perceive this ontological reality because we are viewing it through our cognitive lens (Confrey, 1990; Y. S. Lincoln & Guba, 2011), interpretations of radical constructivism can often stray into the misapprehension that this lens completely distorts the way each of us sees the real world. However, it is my belief that although we can never directly access an ontological reality, our ability to falsify theories and communicate with others allows us to build up a "logically possible" world (Popper, 2005, p. 458) that we judge as adequately close to an ontological reality in terms of our own goals and values. Confrey (1990) suggests that this is possible: one of his criteria for 'powerful' constructions is that the student's construction is "in agreement with the experts" (p. 112). He is therefore saying that, across different cultures and through different cognitive lenses, there is some way for all of us to independently create a compatible experiential reality from our differing views of the world, and therefore our lens is not entirely distorting. This is shown by the phenomenon of multiple discovery, where multiple scientists simultaneously and completely separately make the same discovery (Lamb, 1984). Although we cannot ever assess the absolute truth of our conceptions (von Glasersfeld, 1995), we can narrow down the possibilities through falsification and social interaction in order to triangulate our constructions against others who have different cognitive lenses (Flick, 2014).

Constructivism is the worldview that underpins my research project. This worldview offers a coherent conceptual framework within which to locate my project. This affects my chosen methods, both for obtaining my data and doing my analysis, as my data is created with my participants, not simply collected from them. I do not have direct access to their realities, and their attempts at describing it to me will in turn be filtered through my own cognitive lenses. I have borne this in mind throughout this project.

## 2.3 Perspectives on Learning

This section explores some key perspectives on learning, following a chronological journey through behaviourism, cognitivism, and ending in constructivism. It is important to recognise that these are certainly not the only learning theories, and there is still debate today on how these learning theories have progressed and fit together. However, for the purposes of this thesis, I have chosen to present a simplified version of events.

It is important to consider these perspectives on learning since beginning to understand and critically approach the process of *how* students learn is a vital part of educating. Only by considering theories of learning can we, as educators, design appropriate and effective learning environments for our students (Ertmer & Newby, 2017). Even in higher education, we are moving away from models of passive knowledge transmittance through lectures; instead, the focus is being placed on interaction and construction (Kay et al., 2019). Through interaction with students we can assess the extent to which they understand the content and its context, and gain insights into the reasons for students' misconceptions and struggles.

### 2.3.1 Behaviourism

In the early to mid twentieth century, Watson (1928, 1930) and, later, Skinner (1945, 1963, 1988), put forward a theory of learning influenced by logical positivism: behaviourism (Duit & Treagust, 1998; Millward, 1984). Behaviourists claimed that learning could be entirely understood by examining behaviour (Skinner, 1984a). They believed that behaviour is shaped by 'operant conditioning', where associations are created between an observable stimulus and a behaviour or response. A stimulus may reinforce behaviour by increasing its frequency (positive reinforcement) or by reducing it (negative reinforcement). For behaviourists, these modifications constitute learning, and there is no direct reference to cognitive or affective processes. Rather than being student-focussed, the outside influencing agent is the main operator in the behaviourist theory of learning (Catania, 1984; Skinner, 1984b). Behaviourism ignores the processes that the student is going through to reach an outcome, deeming them irrelevant as long as the desired result is achieved; it is focussed on the convergence of the outcome, and has no use for the idea of metacognition and learning how to learn. Behaviourist teaching rewards memorisation and training rather than understanding. Furthermore, the emergence of behaviourism as a learning theory at all could be seen as a political shift in strategy for the discipline of psychology, since throughout the early 1900s psychology was striving to reframe itself as a respectable science (Koch & Leary, 1985).

Despite Skinner's defence of behaviourism continuing until the late 1980s (Skinner, 1989), this learning theory was broadly replaced by the European ideas of cognitivism from the 1960s (Mandler, 2002; Duit & Treagust, 1998).

### 2.3.2 Cognitivism

Cognitivism is the idea that intelligent behaviour, as opposed to automatic, is the result of cognitive processes such as thinking, memory and purposeful learning and goal-setting (Petri & Mishkin, 1994), rather than the operant conditioning suggested by behaviourism (Deigh, 1994; Haugeland, 1978). The focus is on how learners acquire new knowledge (Ertmer & Newby, 2017). Cognitivism suggests that actions and solutions to problems can use previously-held information combined with new information (Petri & Mishkin, 1994), and that the learner is active in synthesising and structuring this new information (Ertmer & Newby, 2017). Cognitivism, in a similar way to behaviourism, suggests that external influences are a large factor in facilitating a student's learning, however the difference lies in that the learner's thoughts and beliefs also have a major effect (Ertmer & Newby, 2017). Again, like behaviourism, memory and memorisation play a large part in cognitivist thinking, but cognitivism focusses on the student's processing of the knowledge rather than the external environment.

The nature of reality for cognitivists is also different than for behaviourists. For cognitivists, there is an external reality that is interpreted, and that knowledge is a negotiation for each individual between their experience of the world and their cognitive processes (Cooper, 1993; Siemens, 2014).

### 2.3.3 Constructivism

Towards the end of the twentieth century, researchers began to find that students' actual learning in the classroom was often very different from the outcomes that were intended and expected (Bodner, 1986; Perkins, 1991). This resulted in students often holding partially-formed or incorrect conceptions, and sometimes attempting to use two mutually-exclusive conceptions to explain one phenomenon (Duit & Treagust, 1998; Fosnot & Perry, 2005; Scaife, 2007). These findings were inconsistent with both the behaviourist and the cognitivist theories of learning. The idea of constructivism as a learning theory began to emerge. Although constructivism as a learning theory is compatible with, and necessarily preceded by, constructivism as a worldview, it is important to recognise the distinction. As a worldview, constructivism attempts to define the relationship between experience, ontology and epistomology, whereas as a learning theory, it attempts to explain how students learn (Bada & Olusegun, 2015; Merriam, 2001; Petrina et al., 2008).

The core tenet of constructivism as a learning theory is that students' current knowledge affects how they actively interpret and accommodate new experiences and newly-acquired knowledge (Olssen, 1996; Seimears et al., 2012; von Glasersfeld, 1995), and that each student's reality is necessarily self-constructed and therefore personal (Siemens, 2014). Students' past ideas, as well as cultural factors, affect how they incorporate new experiences, and new knowledge is filtered through the individual's perception (von Glasersfeld, 1995). This results in a complex series of events in the learner's cognitive structures when encountering new material and experiences. Students, consciously or unconsciously, compare the new knowledge with their current knowledge framework. If the new elements logically fit into the student's current framework, then these elements are usually assimilated readily into the current knowledge structure (Scaife, 2007; von Glasersfeld, 1995). However, if elements of the new knowledge do not seem to fit, a number of different types of rejection or accommodation can happen. The most simple of these is that the incompatible experience does not pass through the individual's filter, and is discarded entirely (Fosnot & Perry, 2005; Scaife, 2007; von Glasersfeld, 1995). Another potential outcome is that the student will hold both the initial idea and the new idea simultaneously, usually compartmentalised for use in separate, specific situations (Duit & Treagust, 1998; Fosnot & Perry, 2005). Sometimes the incompatibility between new and current knowledge will cause perturbation, or cognitive conflict, in the individual, until equilibration (elimination of the perturbation) is achieved through the construction of new knowledge recognition patterns in a more-encompassing model, changing and updating the student's knowledge framework (Fosnot & Perry, 2005; Piaget, 1964; von Glasersfeld, 1995). Piaget (1964) suggests that knowledge arises from a process of creation and transformation as a path to understanding, and that knowledge is intrinsically linked to other processes, organised within a large structure held by the individual.

The key point from this is that learners interpret the world through a variety of cognitive lenses. They are constantly falsifying and triangulating new information without realising. This is part of how they accommodate new experiences into their knowledge frameworks. The main difference between constructivism and previous learning theories is that in constructivism, learners create meaning from what they experience, they do not simply see the outside world and absorb the information (Ertmer & Newby, 2017).

## 2.4 Learning Frameworks

Behaviourism, cognitivism and constructivism are three of the main theories of learning in education research. In addition to these, there are various learning frameworks, some of which sit within the three main theories, and some of which sit without. This section will examine two of the learning frameworks relevant to this thesis: cognitive load theory and Bloom's Taxonomy. Both of these learning frameworks are compatible with a constructivist worldview and constructivist teaching, since they attempt to take account of learners' mental processes.

### 2.4.1 Cognitive Load Theory

Cognitive load theory explores students' processing capabilities with regards to their working memory and transition into long-term memory (Sweller et al., 2019). Students have a limited amount of processing power which is restricted primarily by the working memory. The working memory can only process a small number of "information elements" at a time – this is the cognitive load (Sweller et al., 2019, p. 262). When the cognitive load overtakes a student's capacity to process it, the student is less able to learn, and information transfer into long-term memory is impeded (Sweller et al., 2019). This is particularly a problem for the design of multimedia resources and learning environments (Mayer & Moreno, 2003). It is therefore important to take design principles into account when creating learning instruction.

Cognitive load can be decreased by a number of different methods. Simpler tasks with low variability and high levels of guidance and feedback both reduce cognitive load, but unfortunately also decrease long-term retention, which is the opposite of what we want (van Merriënboer et al., 2006). Where students are expected to learn new material and a new platform (in this case, a spreadsheet), presenting information gradually, allowing it to be scaffolded by students' current knowledge frameworks, and then building up complexity works to both reduce cognitive load and increase retention for students with lower initial levels of knowledge (T. Clarke et al., 2005). This suggests that having to learn a technology or a platform while attempting to learn new material is likely to overload a student's cognitive capacity. Van Merriënboer et al. (2006) suggest that learning tasks should be presented as part of a suite, some of which have low variability and require a low cognitive load, combined with higher-load tasks that are germane to the student's construction of knowledge.

Table 2.4.1 suggests further ways to decrease cognitive load for students. Compound effects, which rather than having simple effects on working memory actually affect the other methods, have not been included in this table. Methods that actually increase cognitive load, but have positive effects on knowledge construction, have also not been included. Examples of this include the self-explanation effect, where students are given worked examples with prompts to explain to themselves the different steps in the problem.

### 2.4.2 Bloom's Taxonomy

Bloom's Taxonomy describes a set of educational cognitive objectives that provide institutions with a common language and basis for writing learning outcomes (Krathwohl, 2002; Stanny, 2016). The taxonomy begins with simple goals, and progresses to more complex ones requiring mastery of previous levels. The Revised Taxonomy updates the original taxonomy with a refocus and incorporation of new knowledge, and incorporated a second dimension into the framework, resulting in a knowledge dimension and a cognitive process dimension (Anderson et al., 2001). In recent years, there have been suggestions for an extension to the Revised Taxonomy, sometimes called Bloom's Digital Taxonomy, which in turn incorporates methodological language that reflects the nature of our digital interactions (Wedlock & Growe, 2017).

According to the Revised Taxonomy, each educational objective should have a verb portion to indicate the cognitive process, and a noun portion to indicate the content knowledge (e.g. "learn to *apply* the *reduce-reuse-recycle approach to conservation*") (Anderson et al., 2001, p. 32, my emphasis in italics). Figure 2.4.1 shows the cognitive process dimension of the Revised Taxonomy, along with example processes. These are only the example processes taken from Anderson et al. (2001) and it is not a complete list by any means. In addition to the methodological additions suggested in Bloom's Digital Taxonomy, educators over the years have added their own verbs to describe processes within each level of the Taxonomy.

**Figure 2.4.1**
*The cognitive processes of Bloom's Revised Taxonomy (Anderson et al., 2001)*

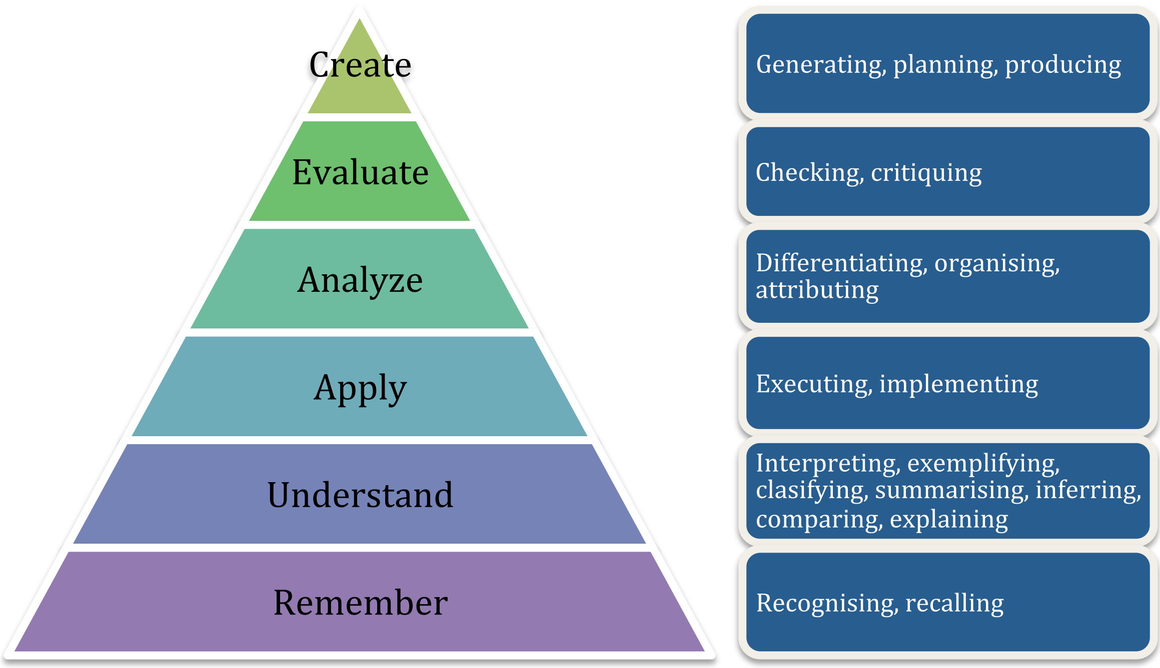


**Table 2.4.1**
*Methods of reducing cognitive load, benefits, and references. Adapted from Sweller (2019) and Mayer and Moreno (2003).*

| Method of load reduction | Benefit | Reference |
|---|---|---|
| No specific goal presented in a question (e.g. "Calculate as many variables as you can" instead of the traditional "What is the final velocity?"). | The student does not have to hold the problem state, goal state, relationship, and any sub-goals in their working memory, and do problem-solving simultaneously. | Goal-free effect (Sweller & Levine, 1982) |
| Providing worked examples for students to study, modelling the problem-solving process. | Worked examples enable students to focus on the process of problem solving and generalise solutions for that type of question. | Worked example effect (Sweller & Cooper, 1985) |
| Providing partial solutions that students must complete. | Worked examples don't necessarily force students to study the process. Providing partial solutions that students have to complete forces them to engage. | Completion problem effect (van Merriënboer & Krammer, 1987) |
| Information is integrated into one source, instead of multiple sources of information. | Students no longer have to mentally integrate two different sources of information in their working memory. | Split-attention effect (Tarmizi & Sweller, 1988) |
| Figures and accompanying text should be aligned within a graphic. | Students no longer have to search for which text goes with which diagram, freeing up their working memory. | Integrated presentation (Moreno & Mayer, 1999) |
| One source of information is better than multiple sources of the same information (e.g. diagram and text). | With two sources of the same information, students have to expend more effort and processing power to determine they are the same. | Redundancy effect (Chandler & Sweller, 1991) |
| Problems and tasks that are similar decrease load, and those that are sufficiently different increase load but also knowledge transfer. | Reduce non-productive extraneous processes to allow space in the working memory for useful processes germane to learning. | Variability effect (Paas & van Merriënboer, 1994) |
| Extraneous material that doesn't directly aid the student's understanding is omitted. | The working memory is used only for essential processing and helps student select relevant information. | Coherence effect (Moreno & Mayer, 2000) |
| Working memory has two modes, visual and auditory, both of which are used. | Using both visual and auditory channels of working memory can increase student's overall processing power. | Modality effect (Mousavi et al., 1995) |
| Successive information is presented gradually, in controlled segments. | Allows students time to process the words and images in their working memory. | Segmentation effect (Mayer & Chandler, 2001) |
| Information elements that interact with others are first presented as separate elements, and the interaction is introduced later. | Uses less working memory at each step, and allows students to commit individual elements to long-term memory before integrating them. | Isolated elements effects (Pollock et al., 2002) |
| Signalling (titles, subheadings, indicator statements, font differences) directs students on how to process the information. | Reduces need for the student to decide what information is important, allowing them to focus their processing on the content. | Signalling effect (Lorch, 1989) |
| Tasks are collaborative rather than individual. | Collaboration allows the cognitive load to be distributed across the working memories of multiple group members. | Collective working memory effect (F. Kirschner et al., 2009) |
| Animated resources are better for learning tasks involving movement. | "Biologically primary" knowledge evolutionarily uses less working memory, and observing and copying movement is a biologically-primary method. | Human movement effect (Paas & Sweller, 2012) |

Table 2.4.2 presents Bloom's Taxonomy as a table. The cognitive process dimension demonstrates the verb – what the objective suggests the student should be doing. The knowledge dimension demonstrates the noun – what piece of knowledge the objective pertains to. Each objective written using the Taxonomy could be placed within a cell of the table. The two-dimensional table is particularly useful for helping educators recognise the relationship between knowledge and the cognitive processes (Anderson et al., 2001), as well as identifying gaps in activities and assessments (Anderson et al., 2001).

**Table 2.4.2**

*Bloom's Revised Taxonomy Table (Anderson et al., 2001)*

| The Knowledge Dimension | The Cognitive Process Dimension | | | | | |
|---|---|---|---|---|---|---|
| | Remember | Understand | Apply | Analyse | Evaluate | Create |
| Factual knowledge | | | | | | |
| Conceptual knowledge | | | | | | |
| Procedural knowledge | | | | | | |
| Metacognitive knowledge | | | | | | |

Bloom's Revised Taxonomy does suggest that students should be able to fulfil the cognitive processes of lower levels before progressing to higher-order levels, although this is less of a rigid requirement that the original Taxonomy (Krathwohl, 2002). However, some studies have found that having mastery of the lower levels does not actually improve performance at the higher levels (Agarwal, 2019; Dobson et al., 2018). While this may not be the case, the isolated elements effect of cognitive load theory suggests that presenting factual information first, and then building in complexity and interactions later, can help reduce a student's cognitive load (Pollock et al., 2002). Therefore, although initially focussing purely on facts might not help performance at higher levels later, it may help some students to process the content more readily.

## 2.5 Technology-Enhanced Learning and Learning Technologies

This section discusses the definitions of technology-enhanced learning (TEL), technological learning environments (TLEs), and learning-enhancing technologies within the literature. It also explores potential benefits, and what constitutes student 'experience' of TEL and technology.

### 2.5.1 Definitions

Technology-enhanced learning and the use of learning-enhancing technologies has been a focus of research within education for quite a number of years (Barak, 2007; A.-Y. Chen et al., 1999; de Freitas et al., 2015; Korsgaard, 2006; Owston, 1997), with educational institutions adopting and investing in technology systems to help their students (R. Walker et al., 2016). However, TEL has no single agreed definition within the literature. This may be due to its diverse nature, and the fact that new technologies are arising frequently, and those that already exist are constantly evolving. Many papers fail to define it at all. With so many institutions and educators putting emphasis on including elements of TEL within their courses, there may be a point in the future at which the term 'TEL' (or derivatives) goes extinct, in favour of the use of technology simply being part of the broader term 'learning'. However, for the present, this is not the case, and the inclusion of technology in a course is still a cause for comment for many educators.

Part of the trouble in defining TEL is that 'technology' can be used in so many different ways in education. It can be used to describe pedagogical contexts such as flipped, blended, distance, or online learning, but also to describe the use of a virtual learning environment (VLE), or a single activity that uses a single piece of technology (Gregory & Lodge, 2015). TEL is also often misused as a synonym for 'learning technology'. Walker et al (2014 p. 2, in Loughlin, 2017) define TEL as "any online facility or system that directly supports learning and teaching", but this is obviously limited in that it only refers to the online technologies themselves, venturing more into the territory of the technological tool rather than the learning process. Goodyear and Retalis (2010, p. 1) offer a broad definition, of "situations in which technology is [also] being used to help people learn". Although this definition addresses the 'enhanced learning' end of TEL, it does not suggest what exactly is meant by the 'technology' side. 'TEL environments' are often computer-based or online systems where students use technological resources to facilitate their learning, either by accessing teaching materials or completing online activities before or during class. This difficulty in defining TEL has been presented as a criticism of TEL itself (Njenga & Fourie, 2010), however this is misunderstanding the nature of the term, as TEL seems obviously an umbrella term, in the same way that 'face-to-face teaching' may constitute a very large number of different types of activity.

With ever-increasing internet and network speeds, education can incorporate more and more web-based technology (S. Kim et al., 2011). This has also resulted in a rise in the use of 'cloud computing', where software and file storage is provided online (S. Kim et al., 2011). Google Drive and Google Docs are examples of cloud computing that have been widely adopted, particularly across academic institutions (Alqahtani, 2019; Liu & Lan, 2016; Nithya & Selvi, 2017), although there are many others. The increased use of cloud computing in education has led authors to suggest the term 'cloud-based learning' as a replacement for 'TEL', indicating a move to web-based and online resources (Leony et al., 2013; Mikroyannidis et al., 2010). However, although cloud-based learning is undoubtedly a useful term for this type of resource, it is not a replacement term for TEL. Cloud-based learning can only be considered one facet of TEL, since it does not include technologies that are not web-based, particularly hardware such as mobile telephones, but also resources that are accessed offline such as traditional office suites. Therefore, for the purposes of this thesis, I will be adopting the broader scope of TEL I suggested above, and not limiting the study to cloud-based learning or cloud computing, although focussing on these would be an interesting direction for a future study.

For the purposes of this study, I draw on the definition suggested by Law et al. (2016, p. 73), which defines TEL as "learning in an environment that is enriched by the integration of digital technology". Although 'digital technology' is still a diverse set of technologies, it excludes some of the 'technology' suggested in the introduction such as pencils. In turn, it includes hardware such as desktops, laptops, mobile telephones, televisions and e-readers, as well as software such as office suites, social media, online forums and videos (Antoniadis et al., 2009; Loughlin, 2017). However, TEL itself is the process of learning using technology, rather than the technology used. It is worth noting that the use of "TEL" to describe the technology is a trap many academics and educators fall into. The learning technologies and tools used are referred to in this thesis simply as 'technologies' or 'learning-enhancing technologies', and the environments in which the teaching takes place are 'technological learning environments' (TLEs).

### 2.5.2 Benefits

TEL and technology can benefit students in a number of different ways. It can improve their experiences at university, from a pedagogical standpoint and more broadly, for example for welfare issues (G. Akçayır & Akçayır, 2018; Awidi & Paynter, 2019). Student experience can also be improved through lecturers' choices of technologies, which may include VLEs, videos, and the use of social media (Loughlin, 2017). Technology has the potential to remove obstacles to education such as time and proximity limitations, resulting in a more flexible approach (Markova et al., 2017; P.-C. Sun et al., 2008). O'Neill et al. (2004) suggest that a technological learning environment (TLE) is particularly useful for part-time students who may be having to balance their studies with jobs, childcare, or erratic schedules. In my own experience of teaching in HE, I have found that part-time students do tend to have different opinions about the use of TLEs and technologies than full-time students. Some part-timers are much less inclined to use it, although these students tend to be older who are, perhaps, more used to traditional methods of learning, or at least expecting didactic lectures at university. Other part-timers, however, particularly the younger ones, seem to embrace learning technologies more easily, and accept it as a quick and easy way to access and revisit course materials, which is in agreement with observations of O'Neill et al. (2004).

Additionally, learning technologies such as screen readers and recording and planning tools can increase accessibility for disabled students, which is an obvious benefit. However, this raises concerns about the 'digital capital' that disabled students have. Digital capital is the social and cultural support that a person can access in order to be successful. Disabled students often struggle to access the 'correct' type of digital capital that can help them succeed in HE. This is a problem that not only affects disabled students, but also other minorities in HE such as part-time students or mature students (Seale et al., 2015).

The use of TLEs can also develop students' higher-order level thinking, which may in turn increase the students' chances of being academically successful (Jihyun Lee & Choi, 2017; Zohar & Dori, 2003). Higher-level thinking is a movement beyond simple recall and memorisation, and links to the higher levels of Bloom's Revised Taxonomy. Students' attitudes towards technology therefore are important, since if they have negative attitudes, they will not adopt the technology that can help them achieve the higher-order levels, and therefore may reduce the likelihood of academic success. Attitudes towards technology are therefore important to consider when we are incorporating technology in our classrooms and designing TEL environments (Jihyun Lee & Choi, 2017).

TLEs can also increase collaboration between students. Methods of collaboration enabled by technology include: resource- and knowledge-sharing (Al-Emran et al., 2016); resource creation, such as creating student podcasts (M. J. W. Lee et al., 2008); and simply making communication easier, which in turn allows peer feedback and reflection to arise naturally (Jihyun Lee & Choi, 2017). TLEs and TEL are also central to a variety of interactive pedagogies such as blended learning (Dalsgaard & Godsk, 2007), distance learning (Arrosagaray et al., 2019), or flipped learning (G. Akçayır & Akçayır, 2018). These interactive teaching approaches have been found to have a number of benefits in themselves, including improving attainment (Al-Qahtani & Higgins, 2013; Charles-Ogan & Williams, 2015), as well as decreasing subject-specific anxieties (E. M. Marshall et al., 2017).

These interactive pedagogies can help enable students to be active participators in their own learning. This is important, since it encourages reflection, independence, and responsibility, and supports students to take ownership over their own education (Y.-J. Lan, 2018). Technology and TEL have been found to help some students with this self-regulation, and those that don't use it may be simply lacking training in how (Blau & Shamir-Inbal, 2017; Knight, 2012; Yot-Domínguez & Marcelo, 2017). Students who do use technology for self-regulating their learning may use it for choosing their own learning materials, choosing when and how they learn, communicating with other students, or even choosing their own assessment methods (Yot-Domínguez & Marcelo, 2017).

Kukulska-Hulme et al. (2011) found that learners in HE often prefer to use certain technologies for learning, which results in them tending to choose more familiar forms of technology, particularly if they have used them successfully in the past. I have witnessed this, where students faced with using Excel or SPSS for a data analysis, will use the more-familiar Excel despite admitting they found SPSS easier. Sun et al. (2008) found that students who use technology resources cite ease of use and their own confidence with computers and the Internet to be critical factors in their satisfaction with a course involving technology. It is important, therefore, that new TLEs should be designed so that students are comfortable with the technology, and that they feel supported in this (Kukulska-Hulme et al., 2011).

While TEL and TLEs have many benefits, as discussed above, it is important to understand that it is not a panacea. This has been one of the main criticisms of TEL and technology – its opponents suggest that those of us who use it regularly view it as “a saviour” and that “its redemptive power is overreaching and every educational institution should adopt it” (Njenga & Fourie, 2010, p. 202). As well being a rather amusing take on the use of technology, this is certainly a misunderstanding, since research is constantly being done to evaluate and assess different technologies for classroom use (Kintu et al., 2017; Law et al., 2016; Shi et al., 2020; Smidt et al., 2017). Another criticism of TEL and technology is that each technology resource is just information that is not adapted to unique classrooms and contexts (Njenga & Fourie, 2010). While this would be a valid criticism if it were the case, high quality uses of TLEs are adapted to different sets of learners, and, usually, remain a supplement to the learning environment, not a replacement.

Due to an ever-evolving technology landscape, it is important to understand how students adopt particular technologies for learning, and how to keep students engaged with learning-enhancing technology materials and technology-based courses (Kukulska-Hulme et al., 2011; P.-C. Sun et al., 2008). It is also vital that chosen technologies must be an enhancement to learning, not a replacement (O’Neill et al., 2004), meaning that technology should be employed thoughtfully from a basis of good pedagogy, not for the sake of it. In my own experience, this is not always the case. Many teachers and tutors adopt learning technologies due to them being in fashion, or there being institutional pressures upon them to do so. Furthermore, all students are expected to engage with the technology, irrespective of their confidence or knowledge level or background. This, unsurprisingly, means that the use of technology is less successful, and that the students are less successful and less satisfied learners as a result (O’Neill et al., 2004). It is therefore important to design learning activities that are accessible to all.

### 2.5.3 Experience and Quality

Many studies focus on technology or computer ‘experience’ as a potential predictor for attitude or use (Farjon et al., 2019; Martín del Pozo et al., 2017; Sam et al., 2005). However, experience is not necessarily easy to define. It may mean an objective amount of use, or subjective experience (Garland & Noyes, 2004). Experience with technology or TLEs may refer to the general state of experiencing something (Al-Adwan et al., 2013), whether a student is feeling a positive or negative attitude while using it (Farjon et al., 2019), whether others are treating them positively or negatively while using it (Ricciardelli et al., 2020), whether they have used it before at all (Sam et al., 2005), the number of years they have used a specific form of technology or the frequency with which they use it (Martín del Pozo et al., 2017), how good they are at using it (Teo, 2016), their diversity of use (B. Smith et al., 1999), or the amount of opportunity they have had to use it (B. Smith et al., 1999).

Smith et al. (1999) recognise this diversity of definitions, and suggest two broader categories into which technology experience can fall, although they are only considering experience of computers, rather than experience of learning technologies and TLEs as a whole. These two categories are objective computer experience (OCE) and subjective computer experience (SCE). OCE comprises of the measurable interactions a student may have with a computer or other technology, such as amount of use, diversity of use, and opportunity for use. SCE is trickier to define, as it is easily conflated with attitude (B. Smith et al., 2000). It is essentially a summary of a student's cognitive and emotional associations with computer use, and may consist of factors such as a student's perceived enjoyment, perceived competency, perceived usefulness, and anxiety. These two definitions of experience (OCE and SCE) could be easily extended to all forms of TEL and TLEs, and this study draws on several of the aspects discussed.

Students' subjective experiences with technology and TLEs can be affected by a large number of things, including the quality of the technology they're using. Quality of technology use is valued over quantity (Lei, 2010), which is a viewpoint that is in contrast to some opponents of technology who feel that universities are forcing as many technologies as possible upon their staff and students (Njenga & Fourie, 2010). What constitutes quality in a technology resource or TLE is complex in itself, and different stakeholders such as students, educators, or administrators, have different opinions about what quality is (Smidt et al., 2017). In online courses, Smidt et al. (2017) found that students value clarity, availability of instructors, and feedback on their work. In contrast, educators feel that signs of a quality online course are interaction, engaging environments, and rigor comparable with face-to-face classroom experiences, which were ranked at 8th, 9th, and 4th place respectively by students (in a list of 19) (Smidt et al., 2017). Support using technology is also highly valued by students (Markova et al., 2017). These findings indicate that students worry less about the actual technology they are being asked to use, and more about how that technology is situated within their lessons and courses. It is therefore important to reiterate that technologies and TLEs must be carefully thought about, particularly in how they relate to pedagogy and student experience.

## 2.6 Mature Students

### 2.6.1 Characteristics of Mature Learners

Most universities in the UK define undergraduate mature students as 21 years old or over (HEFCE & OFFA, 2014; Howard & Davies, 2013; Richardson, 1994a, 1994b; Tett et al., 2012), although this may be because this is how UCAS defines it (UCAS, 2020a). Table 2.6.1 shows the minimum age of a mature student as stated on the webpages of the top ten UK Universities as defined by the Times

Higher Education (THE) World University Rankings 2020. I have also included the University of Sheffield.

**Table 2.6.1**
*Definitions of a mature student by the top ten UK universities in 2020*

| University | Age of mature | Reference |
|---|---|---|
| University of Oxford | 21 | (University of Oxford, 2020) |
| University of Cambridge | 21 | (University of Cambridge, 2020) |
| Imperial College London | None specified | No specific mention of mature students on their website |
| UCL | 21 | (UCL, 2018) |
| London School of Economics and Political Science | 21 | (London School of Economics and Political Science, 2020a) |
| University of Edinburgh | 22 | (The University of Edinburgh, 2020a) |
| King's College London | 21 | (King's College London, 2020) |
| University of Manchester | 21 | (The University of Manchester, 2020a) |
| University of Warwick | 21 | (The University of Warwick, 2020) |
| University of Bristol | 21 | (University of Bristol, 2020) |
| University of Sheffield | 21 | (The University of Sheffield, 2020a) |

Although it is common to define mature students as 21 years old or more at entry into an HE establishment, I felt that this age was too low for my definition of a mature student. An applicant could be out of education for less than three years, and upon returning be classed as a mature student. Some universities, in addition to being mature, also consider 'adult returners'; these are applicants who have been out of education for three years or more (The University of Edinburgh, 2020a). However, this can still result in students being as young as 21. Lewis (2018) found that students aged between 21 and 25 felt, when comparing themselves to the 18-year-old entrants, that there was very little difference between them. Some studies suggest that in order to be defined as mature, students should be at least the age of 25 (Baglow & Gair, 2019) or 30 (e.g. Mackey et al., 2018), and I have had conversations with colleagues who feel that mature students should be defined as those over 50. However, for the purposes of this study, I have adopted the definition as suggested by Baxter and Britton (2001) where mature students as defined as those aged 26 and older. This age also acknowledges the students' perspectives on how different they feel reported by Lewis (2018).

The number of mature students in higher education has been generally increasing for several decades (Nation & Evans, 1996; Pearce, 2017; Schuetze, 2014), although in recent years application numbers have fallen, possibly due to increases in tuition fees (UCAS, 2017). In 2017, the Universities and Colleges Admissions Service (UCAS) found that 10.4% of successful UK applicants to higher education were mature, and in 2018, the number of acceptances for students aged 26 and over increased by 6.7% (UCAS, 2017, 2018). Data for 2019 shows that acceptances for older age groups, particularly those aged over 30, have increased significantly (UCAS, 2019). This is in line with a general trend over the last few years of increasing acceptance rates for the mature students who do apply. It is therefore important that we make sure we are considering mature students when designing our pedagogies.

Despite defining mature students by their age, they are naturally a diverse, heterogeneous group. It is important to remember that they are of different genders, and from different nationalities, cultures, socioeconomic groups, and educational backgrounds, and they all have vastly different rationales for studying in HE (Schuetze, 2014; Waller, 2006). Bearing in mind that mature students are so diverse, Blaxter, Dodd and Tight (1996) identified a set of seven potential characteristics of mature students, of which the student may fulfil one or more. These are:

- higher age than a 'traditional' student
- in full-time, non-manual employment
- restarted education sometime after the end of compulsory schooling
- academic study experience before starting degree
- often have non-standard entry requirements for HE
- positivity about HE study
- interest in post-graduate study

This list obviously encompasses a wide range of people. In fact, Waller (2006) argues that the phrase 'mature student' is simply a convenient term for academic institutions, and beyond that has little value. Waller suggests that in order to study mature students, one should perform case studies of individuals, due to the inability to categorise them sufficiently. I do not think this level of individualisation is necessary for this study, since it is about the relationship between age and attitudes to TEL, and defining mature students in terms of their age is a useful tool for age-related studies in HE. I do, however, agree that it is important to maintain an awareness of the heterogeneity of mature students in order to avoid overgeneralisation, and that being 'mature' is just one facet of their complex status.

As well as (or perhaps instead of) thinking of mature students in terms of their age, the age threshold of 26+ may hold more value in terms of their life trajectory. Instead of classifying students by a protected characteristic (Malleson, 2018), we can recognise the diversity inherent in mature students and think about them in terms of their goals. One of the goals we can consider is the background behind why a mature student may be returning to HE. West and Hore (1989) suggest that there are four main groups of mature students, who can be classified according to their educational background: "early school leavers" (p. 343), who left school before gaining the qualifications that would allow them to apply to HE normally, but now wish to return to education; "recyclers" (p. 343), who already have an HE qualification but wish to change field or progress to higher-level degrees; "returners" (p. 343), who started an HE course but discontinued it, and now wish to resume their studies; and “deferrers” (p. 343), who left school with the entry requirements for HE, but wished to wait until attending. Schuetze (2014) adds two further groups: those who are attending for professional reasons, especially on shorter courses (I will call these “professionals”); and those who are studying only for their own personal interest (whom I will call “personal fulfillers”).

Some of these groups have educational gaps, and some may not. Early school leavers and deferrers will almost certainly have a gap of a few years between their secondary and tertiary education. Returners are likely to have a gap, but not necessarily. All of the other groups may have educational gaps, but a gap is not implied by the definition of the group. However, since West and Hore (1989) only included students aged 25 or over in their study, it is likely that all of the students in their sample had an educational gap of some description. Whether or not a student has had an educational gap may lead to differences in their learning needs in HE. In my experience in a foundation-year department where most of the students are mature, I have found that students with longer educational gaps may have forgotten certain skills, such as time management, study skills or exam practice, that they learned at school and need to relearn them as they enter HE. This may put them at an immediate disadvantage compared to younger students who have less to learn. Early school leavers in particular may have never even had these skills in the first place, as they may not have any traditional qualifications. Having said that, many students who have these educational gaps may have held jobs or gained other life experience. The value of this cannot be discounted, and in many institutions, it is explicitly recognised as such, for example, a department for lifelong learning’s website home page states, “We value life and work experience, and lack of traditional entry qualifications is no barrier to entry” (The University of Sheffield, 2020b).

### 2.6.2 Retention and Risk

Mature students have been found to be less likely than younger students to complete a course in higher education (Bolam & Dodgson, 2003; Cotton et al., 2017; Edwards & McMillan, 2015; Hope & Quinlan, 2020; McGivney, 2004). Unfortunately, this fact has persisted over the years.

The low retention rate of mature students may be due to a number of different reasons. Some institutions waive standard entry requirements for mature students, particularly if offering them a place on a degree with a foundation year (Richardson, 1994b; The University of Sheffield, 2020b). This may mean that mature students who did not follow traditional entry pathways may struggle with the academic culture that they missed out on, particularly if they are ‘first generation’ with no one to guide them (Dunn, 2019). They may also struggle with missing study skills or other academic demands due to being out of practice (Bolam & Dodgson, 2003; Richardson, 1994b). As previously mentioned, universities who do accept students without traditional qualifications try to recruit those who can demonstrate they have gained the appropriate skills through other life experience. Unfortunately, students are not always able to successfully transfer these skills to higher education.

Mature students are more likely to have families, part-time jobs, or caring responsibilities (McGivney, 2004), and maintaining their finances and work-life balance are common reasons for students to leave HE (Bolam & Dodgson, 2003; Edwards & McMillan, 2015). This in turn may contribute to health issues that cause them to drop out (Edwards & McMillan, 2015). Mature students are also more likely to leave HE due to dissatisfaction with their experience (Bolam & Dodgson, 2003; Edwards & McMillan, 2015).

Mature students tend to have lower self-esteem than younger students, and this becomes particularly apparent when receiving feedback in university (Tett et al., 2012; Young, 2000). In HE institutions, grades tend to be lower than expected and the feedback tends to be less supportive (Tett et al., 2012), or otherwise vaguely positive with no real action points (Duncan, 2007). Some students struggle to generalise feedback, so they do not see how feedback on one assignment can help them on future assignments, although this may be due to the quality of the feedback received (Duncan, 2007). This may therefore exacerbate the worry of mature students, particularly as they are concerned about being judged by their educators and peers (Chapman, 2017). Mature students generally find that the first assessments in their course provoke the highest levels of anxiety, and this is particularly true for older students returning to education after a gap (Chapman, 2017; Young, 2000). It is also worth noting that academic attainment is not always correlated with self-esteem (Young, 2000), again especially for mature students, as low self-esteem may be the reason they did not attend university at a younger age. In my experience, mature students do have generally lower self-esteem than traditional students, although a very small minority appear to me to have an unwarrantedly high self-esteem. As well as students placing expectations on themselves of high academic performance, they may feel that their lecturers and tutors are doing so too, which can increase the pressure they feel to perform well.

According to Dunn (2019), many institutions and educators approach mature students with a 'deficit model', assuming that they have limitations and disadvantages that younger students do not, and view them, therefore, as lacking or needing to be fixed. This can be problematic, as students pick up on staff attitudes, and this can may students feel that they are more limited than their peers (Moriña Díez et al., 2015). Furthermore, students who are told that they have limitations can begin to behave accordingly, and thus it becomes a self-fulfilling prophecy (Richardson, 1994b). Dunn (2019) suggests that it is therefore important that educators who are teaching students who would normally be considered 'deficit', such as mature students, explicitly approach their students with an asset model in mind. Asset models focus on the skills and strengths that students do possess, which is opposite to the deficit model, but may also include developmental areas to allow recognition of individualised development that may be needed for each student (Dunn, 2019).

Mature students can feel isolated in HE, and find it difficult to integrate with the wider cohort of younger students (Tett et al., 2012). This is something that I have seen in my classes of mature learners, as students of similar ages tend to seek each other out and work together. It is my impression that younger students actually tend to be more intimidated by the older students, particularly if the older student is academically confident or successful, and this may contribute to the isolation of mature students. The potential of TLEs to lubricate and facilitate interactions is therefore desirable, and according to studies by Howard and Davies (2013) and Sun et al. (2008), may help create a shared cohort identity including all of the different ages.

This feeling of isolation may also be a result of the mature student entering HE study in the first place. Many mature students report feelings of empowerment and social mobility, but also dislocation (Baxter & Britton, 2001). This may in turn place stress upon their relationships with family and friends, since the student may begin to feel a sense of superiority, or may be perceived by their family as doing so, perhaps undeservedly. This is a risk that is particularly common for female students, as the gender roles within the household may be altered as the student needs to take time to study instead of complete domestic tasks (Baxter & Britton, 2001; McGivney, 2004). This may also cause additional stress for the student, since she may feel guilty for not spending as much time in the role of wife, mother, or homemaker (Bolam & Dodgson, 2003).

A higher proportion of students who are 'working class' (as opposed to 'middle class') access HE later in their lives as mature students (Egerton, 2001; Egerton & Halsey, 1993). Although it is worth noting that these studies were done several years ago and therefore may not be completely representative now, my experience with recruiting mature students is that many of them are from lower socioeconomic backgrounds. Students from working class backgrounds may be viewed as more likely to fail in education (Reay, 2001), and socioeconomic status is often viewed as an indicator of available educational opportunities (Wakeford, 1993). Even today, although overall entry numbers are growing, students from lower socioeconomic groups are much less likely to enter HE; in 2019, only 13.1% of the most disadvantaged students entered HE compared to 57.7% of the most advantaged (UCAS, 2020c). To combat these deep-seated views about working class students, and to feel more comfortable in the middle class university environments, students from disadvantaged background may choose to attend less well-ranked universities that they feel can relate to them more (Reay, 2001; Woodward, 2020).

The risks in entering HE may cause mature students to compartmentalise their lives into two parts: the 'student self' and 'who I used to be' (Baxter & Britton, 2001). This is particularly true when they are interacting with people who knew them before they started university, where they may choose to present themselves as 'who I used to be'. They may approach their HE education as a job, and present it to others as an alternative to a career (Waller, 2006). However, despite the risks to themselves and their lifestyles, mature students are, according to Waller (2006), more willing and able than younger students to make the necessary sacrifices in order to achieve their educational goals.

### 2.6.3 Learning Approaches and Preferences

There have been some suggestions that mature students have lower cognitive abilities than younger students, and that this declines as they age (Richardson, 1995). Woodley (1984, in J. T. E. Richardson, 1994a) suggests that the peak of academic performance is between 26 and 30, however this was presented as an argument against mature students having a reduced mental capacity. In fact, Richardson (1994b) found that the academic performance of mature students was as high as that of younger students. Several studies have found that mature students achieve higher degree classifications than their younger counterparts, or at least that there is no negative correlation between age and academic performance (Hayden et al., 2016; HEFCE & OFFA, 2014).

Van Gerven et al. (2002) suggests that as people age, their cognitive skills in some areas, such as crystallised abilities, grow, while they decline in other areas such as working memory. Crystallised intelligence is related to one's knowledge base, which is in contrast to fluid intelligence which is about reasoning and thinking skills (Sligh et al., 2005). The reduction in working memory efficiency as we age includes overall reduced capacity, slower processing speed, and difficulty distinguishing relevant information from distractions (Paas et al., 2001). The methods of cognitive load reduction described in Table 2.3.1 are therefore useful to mature students, since working memory capacity is affected by cognitive decline. Load reduction methods will also help students in both processing and distinguishing relevant information. Reducing extraneous information in multimedia learning materials and increasing signalling will combat coherence and modality effects. Collaboration can also help mature students in particular, as the collective working memory effect allows cognitive load to be distributed across the members of a group. It may therefore be useful to encourage mature students in particular to form study groups in HE, which some studies have already found they are more likely to do (Hamilton & O'Dwyer, 2018).

The learning 'style' of mature students is generally considered different from that of younger students (Howard & Davies, 2013; Richardson, 1995). Learning styles such as visual, auditory and kinaesthetic (VAK) (Surjono, 2014) have been thoroughly debunked, although they are still used by a third of HE educators, and believed to be relevant by over half (Husmann & O'Loughlin, 2019; P. A. Kirschner, 2017; Newton & Miah, 2017). However, the VAK styles are only one set of possible categorisations. Another categorisation is deep and surface learning, which, while they have been called 'learning styles' in the past, are more appropriately termed 'learning approaches' (Dolmans et al., 2016). This reframing moves away from the flawed terminology of an inherent, immutable style of learning that each of us possesses, and towards the way in which a student chooses to learn at a given moment (Rubin et al., 2018). Table 2.6.2 shows some of the characteristics associated with deep and surface learning. Deep learning is considered the more desirable approach, due to its emphasis on the integration of new knowledge into existing knowledge networks (Baeten et al., 2010; Richardson, 2013).

**Table 2.6.2**
*The deep and surface learning approaches, adapted from Entwhistle (1987) and Richardson (1995, 2013)*

| Deep approach | Surface approach |
|---|---|
| Meaning based | Reproduction based |
| Desire to understand | Desire to complete requirements of tasks |
| Rigorous content engagement | Memorisation of content required for assessments |
| Integrating new knowledge with previous frameworks | Inability to identify the difference between principles and applications |
| Integrating day-to-day experience with academic concepts | Tasks viewed as externally imposed |
| Evidence and conclusions associated | Lack of synthesis of ideas |
| Reflective and critical of arguments | Unreflective about goals or methods |

Some studies have found that younger students tend to employ surface learning, and older students tend more often to use deep learning approaches (Howard & Davies, 2013; Richardson, 1994a, 2013). Furthermore, the tendency towards surface learning decreases continuously with age and deep learning increases, indicating that there is no particular threshold for when students switch and that the transition between the two is steady, although the effect size for this was small (Richardson, 2013). The suggested reason for the difference in deep and surface learning approaches is that mature learners have higher intrinsic motivation because they are learning for the experience of learning and creating knowledge, whereas younger students are more focussed towards obtaining a qualification or a job (Rubin et al., 2018). Younger students using surface learning more often may have been influenced by a schooling system that trains students to be exam-focussed, and therefore that learning is externally-imposed, requiring memorisation, and doesn't allow time for reflection. In fact, younger students have commented on this themselves, showing they may have good self-awareness of their approaches (Hamilton & O'Dwyer, 2018).

In contrast to the findings that mature students use more deep learning, however, Taher and Jin (2011) found no difference in surface or deep learning between students of different ages, although their sample ranged from age 27 to 41, so only included mature students. They did find that as a whole, all of these students showed more inclination towards deep rather than surface approaches (Taher & Jin, 2011), which would be consistent with mature students using deeper approaches generally. Hamilton and O'Dwyer (2018), meanwhile, found that although mature students are more likely to be deep learners, there was no difference in surface learning between mature and younger students.

In my experience teaching mature and younger learners, I would broadly agree that mature students tend towards deep learning and younger students tend towards surface learning. My teaching, however, is for a foundation year, where many of the students are aware of this being their second chance for education, so perhaps there is more motivation in my learners. Many of the mature students that I teach seem to be consciously striving to apply the knowledge they learn in class to everyday experiences, trying to make explicit connections between different subjects and events in their lives, and it is often the oldest students who do so most successfully. It may also be that younger learners struggle with this, not necessarily choosing not to make these connections, but having fewer experiences to make the connections to, and therefore being forced into more of a surface learning approach through no fault of their own.

However, the story may not be so simple as students of different ages using different approaches, and this is part of the reason why I have chosen to talk about deep and surface learning as approaches rather than inherent styles. Students have been found to change their learning approach between deep and surface learning depending on the task situation and their goals (Biggs & Tang, 2011). For example, low-level exam-based courses force students to tend towards surface approaches (Jensen et al., 2014). Mature students, aside from deep and surface approaches, also tend to manifest higher use of strategic approaches, where the focus is on maximising their marks (Burton et al., 2009). Certain pedagogies can also encourage this desirable deep learning (Baeten et al., 2010), and since classes tend to be taught in mixed-age groups, this should be able to help students of all ages adopt deeper learning approaches. It has also been found that the use of technology can help with the adoption of these desirable higher-level approaches (Jihyun Lee & Choi, 2017).

### 2.6.4 Mature Learners and Technology

#### *2.6.4.1 Attitudes*

The stereotypical view of mature students, and older people in general, is that they are anxious or fearful about technology, and are poorer and slower than younger students at gaining digital literacy skills (Broady et al., 2010; Czaja & Sharit, 1998; McCann & Keaton, 2013; Scarpina et al., 2020). Some studies have found that older people also engage with technology less than younger people (Czaja et al., 2006). However, when the technology is perceived as useful, they have more motivation to use it and learn it, for example for mobile telephones (Czaja & Sharit, 1998; Mitzner et al., 2010). It is therefore important when designing learning technologies for cohorts involving mature students than the purpose of the technology is made clear.

Prensky (2001) suggested the idea of the “digital native” (p. 1), an individual born after 1984 (P. A. Kirschner & De Bruyckere, 2017) who grew up with technology and so innately understands it. An alternative to the digital native is the “digital immigrant” (Prensky, 2001, p. 2), the older person who did not grow up with technology, but instead has adopted it, but does not have the learned predilection towards it that younger people do. Prensky suggested that there were inherent differences in how these two groups, the natives and immigrants, use technology. The very simplicity and catchy phrasing of Prensky’s ideas seems to have caused some academics to jump on the native/immigrant bandwagon (M. Akçayır et al., 2016; Brumberger, 2011; C. Jones & Ramanau, 2009; Kennedy et al., 2010; Oblinger & Oblinger, 2005; Teo, 2013; Thinyane, 2010). However, dividing society in this way is simplistic, misleading, and may cause more issues that it solves. One of my main criticisms of Prenksy's work (2001) is that it is not based on an actual study; it is an impression formed from observations made in the wild. An assumption that people born after 1984 naturally understand technology and that those born before 1984 do not is absurd. The idea of the digital native has now been widely debunked, with any differences explained by discipline, teaching style, issues of access, and other factors (C. Brown & Czerniewicz, 2010; P. A. Kirschner & De Bruyckere, 2017; Margaryan et al., 2011).

From my conversations with mature students, I have found that older people often compare their ability to use technology to that of younger people, something that is encouraged by ideas such as Prensky's erroneous digital natives and immigrants. They may begin to rewrite their own experiences and thoughts in terms of a comparison with a younger generation. This may cause differences in how they see their skills with technology compared to younger people, although they may experience other inherent biases that cause this, such as those that caused Prensky to opine. This encouragement of comparison may not be helpful to students, and may indeed be damaging, since the act of comparison may make them feel even less confident (Chua & Chang, 2016).

It is worth pointing out, however, that the fact that young people don't have innate technology knowledge does not mean there are not age differences. Technology adoption is complex, and there may be numerous reasons for these differences.

The extent to which students adopt technologies or not can affect their education in positive or negative ways, especially since universities are increasingly embracing TEL and technology (Henderson et al., 2017). One important factor in whether a student adopts a technology is attitude. However, attitudes may change over time, both over years and even during one session of use, depending on whether the student's experience is positive or negative (Broady et al., 2010; Straub, 2009).

Attitudes are difficult to define since they have multiple dimensions and are used in different ways according to the needs of an author or an instrument (Di Martino & Zan, 2010). Broadly, an attitude is an individual's disposition, whether positive, negative, or neutral, towards a subject, where for the purposes of this thesis, the subject is technology and technology-enhanced learning. Hart (1989) suggested that an attitude can be separated into three components: beliefs, emotional response, and behaviour. Hart's definition of overall attitude in terms of these three aspects is particularly useful, since the explicit inclusion of the behavioural aspect links to pedagogical methods and outcomes.

In addition to being difficult to define as a concept, attitudes are difficult to work with. A student will rarely define their attitude towards a subject for you, or even be aware of their own attitude (Di Martino & Zan, 2010). Additionally, attitudes can be multi-dimensional, consisting of several different factors that may change during use (Czaja & Sharit, 1998). Previous literature has explored attitudinal factors relating to TEL and technology, but this has usually been for non-mature students. The factors found include: level of confidence (Garland & Noyes, 2005), which relates to the emotional response component of an attitude; amount of previous experience (Garland & Noyes, 2004), which relates to the behavioural component of attitude; and perceived knowledge level required to use a resource (Levine & Donitsa-Schmidt, 1998), which relates to the belief component. Other factors that contribute to the overall attitude towards technology and TEL include awareness of purpose, usefulness to current need, and availability of support (Czaja & Sharit, 1998). These factors are not necessarily discrete, however; Levine and Donitsa-Schmidt (1998) identified that several of the factors interacted with each other, and there was some degree of simultaneous multicausality.

#### *2.6.4.2 Confidence*

Gardner et al. (1993) found that the more confidence an adult has using computers, the more positive the adult's attitude towards computers, suggesting that the confidence attitudinal factor does indeed affect several other factors of attitude. Conversely, Garland and Noyes (2005) found that attitudes towards computers were not affected by computer confidence per se, but instead by the student's confidence about *learning* using computers. This is an interesting distinction between using computers as an activity in itself, and using computers for a purpose. The difference as perceived by participants may be in the focus: by putting the focus on the computer itself rather than the computer-based activity, it may heighten the student's awareness of what they don't know, rather than allowing them to think of simply completing a task. This is supported by a conversation I had with one of my older mature students, who told me that she used a computer as a strategy to help her learn, but being older, she had to learn how to use it first. She told me, "to use a computer was a big deal for me", and suggested that she both wanted and needed support to do so.

The difference between the findings of Gardner et al. (1993) and Garland and Noyes (2005) may be explained by the passage of time; personal computers were much more common in 2005 than in 1993, so perhaps general computer use has become less of a specialist skill as the years have passed. This is consistent with suggestions by Garland and Noyes in a later study (2008). If computer use is not a specialist skill, but using them for learning is, this therefore implies that using computers and technology for academic work should be considered a skill for which students should perhaps receive training, rather than being left to fend for themselves (Czaja & Sharit, 1998; Garland & Noyes, 2005). This may be particularly true for mature students, since an educational gap may have caused their skill of learning with technology to dwindle over time, or for them not to have gained it in the first place. Another possible downside of the educational gap is that in the time between educational bouts, the technology that the student knows how to use may have become obsolete and fallen into disuse; alternatively, new technologies may have been introduced and become normalised, and the student may simply not know how to use them for learning.

In their 2005 study, Garland and Noyes compared the confidences and attitudes of full-time and distance mature students with level-one traditional undergraduates (Garland & Noyes, 2005). They found that the full-time mature students had a much lower confidence with computers, both in general use and for learning, than their younger counterparts. Interestingly, the distance-learning mature students had the highest confidence regarding the general use of computers, but once again fell below the traditional undergraduates when it came to learning from computers. This is particularly concerning, as much distance learning is conducted via computer-based systems, and if a confident computer user feels uneasy using this platform for learning, then the education system is not working effectively in that regard. It is also interesting that the distance learners had the highest general computer confidence in that case. It may be that only students who were already confident with computers registered for distance learning, but that they then weren't able to successfully study due to lack of experience.

#### *2.6.4.3 Amount of Experience*

Amount of previous experience may then be important in determining attitude to computers and technology. Gardner et al. (1993) found that students who used computers more tend to have higher levels of confidence, and therefore more positive attitudes. They suggest two factors that constitute amount of use: how long the student has been using the technology; and frequency of use. However, Gardner et al.'s study (1993) was conducted over 25 years ago, and computers were less common and less user-friendly in those times. It is therefore possible that frequency of use may have had more of effect in the past than today, where computers tend to be more intuitive.

Several studies have found that, generally, the greater the number of hours one uses a computer out of free choice and not through compulsory work or study, the more positive the attitude of the user towards computers (Czaja & Sharit, 1998; Gardner et al., 1993; Garland & Noyes, 2004), although it is possible that the causality may be in either direction, or even bi-directional and potentially reinforcing. In Garland and Noyes' (2004) study, however, the effect on attitude was small. Garland and Noyes (2004) also found that there is no significant relationship between attitudes and the number of years one had been using computers, indicating that current usage may be the only meaningful usage indicator, although this may simply be a function of how much computers have changed over the years. Operating system revamps happen every few years, and the computing experience changes significantly with each one.

Although increased use of computers means more confidence and a more positive attitude, Gardner et al. (1993) also found that enjoyment can decrease with greater use, which can in turn make the user's attitude more negative. They suggested this may be due to the user having negative experiences with the computer early on in their use of it, resulting in an initial negative attitude; the user may then avoid using computers, and thus the negative attitude persists. This is supported further by Czaja and Sharit (1998) who found that those who didn't use computers tended to have more negative attitudes that those who did. It may also be that after the initial negative experience, continued computer use was compulsory for the participant, which meant that they were being forced to use a technology they already disliked, which led to the perpetuation of the negative attitude in a reinforcing causal loop. It has certainly been found that frustration with technology causes negative attitudes (Czaja & Sharit, 1998). Whatever the reason, it is counterproductive to insist that students must use a technology that they dislike without providing opportunities for positive experiences. This may be more the case for mature students, who may have first used computers and technology back when it was much harder to use; they therefore may have formed negative attitudes that are hard to break out of, particularly if they have avoided using the technology since. This may explain some of the more negative attitudes exhibited by older people around that time (Timmermann, 1998).

As well as amount of use, where and how TLEs and technologies are used might also have an effect on attitude, with a distinction made between technology use at home and use in an educational institution (Garland & Noyes, 2004; Levine & Donitsa-Schmidt, 1998). It will therefore be interesting to ask students about the technology they use for course and non-course activities, as well as about the length of time they have been using each technology, and how often they currently use it.

#### *2.6.4.4 Perceived Knowledge*

A further factor that may affect one's attitude to technology is a student's self-perceived knowledge level, that is, how knowledgeable they view themselves to be (Levine & Donitsa-Schmidt, 1998). Some authors sometimes refer to this concept as "self-efficacy" (Mitzner et al., 2010, p. 1711). Higher perceived knowledge level leads to more positive attitudes and higher confidence (Mitzner et al., 2010). However, it is worth noting that perceived knowledge level may not actually reflect a user's actual knowledge (Radecki & Jaccard, 1995), which in this case would be their skill with a piece of technology. Levine and Donitsa-Schmidt (1998) don't explicitly define knowledge level, but use understanding of terminology and diversity of use as proxies. These proxies seem like a good start to determine knowledge level, since diversity accounts for the amount of time one has spent using technology, and terminology may account for knowledge created from more formal education. However, they do only address factual and procedural knowledge. There are many other factors that affect perceived knowledge level, some examples of which are skill and speed, troubleshooting capability, and awareness of limitations.

One of the problems with knowledge and perceived knowledge level for mature students is that the longer it has been since one created the knowledge, the more likely it is that your knowledge is out of date. In some scenarios, the student may not even realise this, and continue to work using out-of-date information, resulting in poor performance. This is something I have noticed when teaching maths to mature students – sometimes they claim to remember a method from school, but the method they try to use is recalled incorrectly, and produces the wrong answer. Some also struggle to remember how to use certain technology or TLE. It is not uncommon for them to say to me, “it’s been a long time since I did this”, or “it wasn’t done this way when I was younger”. Although some level of technology knowledge is maintained through the use of technology such as computers at home or at work, their overall knowledge level is likely to diminish over time, especially as new technologies are introduced, and the familiar technologies become obsolete. The greater the gap between previous formal education and entry into HE, the more of an issue this will be.

Knowledge is created from learning activities. Russell (1995) suggests six stages to adults learning a new technology. The first stage is “awareness” (p. 175), where they have heard about the technology but not used it. There is therefore an unspoken, implied zeroth stage, where the student has not heard of the technology, and this may be the case for many technologies used in HE. The second stage is “learning the process” (p. 175), where the student is unfamiliar with the technology, but following step-by-step to achieve goals, often with much frustration and lack of confidence. This is followed by “understanding and application of the process” (p. 175), where the student begins to gain in confidence, and understands the usefulness of the technology. Stage four is “familiarity and confidence” (p. 176), where the student is familiar with the technology, and happy with using it. This is often where the use of the technology ends in HE, at least explicitly. Students are asked to complete a task using a technology, and many of them reach either stage three or four before the task is completed. However, there are two further stages, which are very similar to each other. Stage five is “adaption to other contexts” (p. 176), and the student here is able to focus on potential uses for the technology, and no longer focusses on struggling to use it. Lastly, the final stage is “creative application to new contexts” (p. 176), and although Russell states this as a separate stage, it is unclear how it is different from the fifth stage. It is useful to bear these five or six stages in mind when teaching in HE, since the support offered to students needs to guide them through at least the first three stages, and allow the student to grow into latter stages by themselves.

There are therefore clear links between skill, knowledge, and attitude to technology, and these all interact with each other. As the time spent using technology increases, skill and knowledge also increase, leading to overall more positive experiences and therefore more positive attitudes.

#### *2.6.4.5 Technology Adoption Models*

Technology adoption and acceptance models have been used for decades (Scherer et al., 2019; Wingo et al., 2017). These suggest factors that affect how users adopt technology, and are numerous and complex. One of the most commonly-used, both in its original and adapted forms, is the Technology Acceptance Model, or TAM (Davis, 1989). The original TAM included two main factors that contribute to student attitude and adoption of technology, which are perceived usefulness and perceived ease of use. In contrast to some of the studies discussed earlier, where attitudinal factors are internal to the student such as perceived knowledge and confidence, the factors suggested by the TAM are both about the interaction with technology itself, rather than being entirely internal to the user. However, the TAM study was done in a time when technology was less widespread. Modern technology is specifically designed to be easy to use and useful, whether for work or pleasure. Therefore, while these two factors are important, there will be more relevant dimensions in our more technological modern world (Legris et al., 2003).

The TAM2 (Venkatesh & Davis, 2000) attempted to update the TAM by including voluntary versus compulsory technology use, such as the difference between course and non-course use that I discussed earlier, as well as other factors such as cognitive instrumental factors and social influence processes. Although updated, the TAM2 is still an old instrument designed in a world where technology was less prevalent. It is also important to note that the TAM and TAM2 were not designed for use with students. They focus on job performance and productivity for businesses, and although they have been used for student attitudes (e.g. Levine & Donitsa-Schmidt, 1998; Ngai et al., 2007), it has been suggested that the TAM simply performs better in business environments (Legris et al., 2003). Although this could be beneficial for studying mature students, as students aged 26 and over are likely to be approximately the same age as those in the workplace, technology use in a job and in education are very different. Students often don't welcome technology in educational settings (Kennedy et al., 2010).

#### *2.6.4.6 Going Digital*

A study by Lincoln and Tindle (2000) asked mature students about their experiences of using technology in their courses. There were, unsurprisingly, mixed responses. Some students felt that TLEs and technologies were confusing and frustrating, and that it wasted a lot of their time learning how to use the technology. However, most of the responses were positive, with technology generally being perceived as beneficial, especially for students who had online access at home. Being able to access materials online from anywhere is particularly useful for mature students (O'Neill et al., 2004). One of my mature students recently commented to me that she wouldn't have been able to do the course without the online materials. She said she never had technology at school and therefore did badly, and now that she did have access to technology, she could study when and where she wanted: "I'm finally doing well and I'm really enjoying it."

Having materials online is important for students, even if the same information is available in other formats, such as in books. Garland and Noyes (2005) make an interesting comparison between students' attitudes to computers and attitudes to books. Their study finds that attitudes towards these two media are not significantly different, although mature students do, in general, prefer books to computers. There are a number of reasons for this that I can see: it could be due to a lack of computer learning guidance, or perhaps students simply prefer what they are used to, and mature students are used to the ‘old fashioned way’ of learning out of books. Books certainly have a tactile experience that technology does not.

Although learning at home using the Internet or other technologies can be invaluable for some students, Selwyn (2005) suggests that online learners may possibly feel isolated due to the overwhelming amount of unstructured information provided on a course. This is common in HE, where lecturers use their virtual learning environments (VLEs) as content repositories, and may not bother to structure their courses (Chow et al., 2018). Since this alienates students who are trying to learn online, such as mature students, resources provided through online learning or VLEs need to be well-structured and easy to access.

Mature students may also be affected by an inequality in the access and availability of technology across different social groups. One of the divides identified in the literature is along the axis of age (Mitzner et al., 2010; Selwyn, 2005), which is especially pertinent to my study. The lack of access to technology is an important factor when considering mature students and their attitudes to TEL and technology. This has become particularly clear during the COVID-19 pandemic, where universities have had to provide funding or resources for students who don’t have access at home. Other divides are along axes of income, gender, location, and socioeconomic status (Selwyn, 2005), as well as ethnicity (Mitzner et al., 2010; Selwyn, 2005), education level, and computer-specific factors (e.g., self-efficacy with computers, anxiety) (Mitzner et al., 2010).

## 2.7 University Learning and Teaching Strategies

Most universities across the UK mention technology and its use in their Learning and Teaching Strategies. I looked at the most recent Learning and Teaching Strategies for the top ten UK Universities as defined by the Times Higher Education (THE) World University Rankings 2020. Some of the Learning and Teaching Strategies for these Universities are explicitly technology- or digital-based in nature, and some are not, but all contained references to the use of technology or digital education.

Excerpts from the Strategies of the top ten universities referencing use of technology are included in Table 2.7.1. I have also included an excerpt for the institution in which this study was set. I have included the date that each Strategy is applicable for (if available), since this will vary across universities, and may have some effect on the contents. The excerpts are not the only references to technology in the strategy; I have chosen only one illustrative quote, appropriate to learning and teaching.

**Table 2.7.1**

*Excerpts from Learning and Teaching Strategies about use of technology*

| University | Date | Technology-reference excerpt |
|---|---|---|
| University of Oxford | 2018-2023 | "We will ensure that teaching is informed by best practice, an inclusive approach to learning and the opportunities for innovation offered by digital technology." (University of Oxford, 2018) |
| University of Cambridge | 2016-2020 | "The purpose of this Strategy is to outline clearly the University's goals and ambitions in harnessing digital technology to support teaching and learning at Cambridge." (University of Cambridge, 2015) |
| Imperial College London | None specified | "We will use digital and online technology to enhance a sense of collaboration and community between students on campus, to better apply interactive teaching techniques, and to expand possibilities for creating an international classroom." (Imperial College London, 2017) |
| UCL | 2016-2021 | "Additionally, we want to capitalise on the potential of technology to extend and enrich the classroom experience to online learners through virtual classrooms, 'flipping' methodologies and tools and streaming." (UCL, 2016) |
| London School of Economics and Political Science | 2030 | "Enable students to produce diverse outputs, developing digital fluency and entrepreneurial confidence." (London School of Economics and Political Science, 2020b) |
| University of Edinburgh | 2030 | "In reshaping our teaching for the future, we expect to expand interdisciplinary and multidisciplinary, postgraduate and digital education." (The University of Edinburgh, 2020b) |
| King's College London | 2017-2022 | "Change to the King's curriculum and education experience requires implementation of effective and simple systems, and investment in new technologies." (King's College London, 2017) |
| University of Manchester | None specified | "Our teachers will be supported to deliver the highest levels of student satisfaction, embracing digital opportunities and placing personalisation at the heart of what we do." (The University of Manchester, 2020b) |
| University of Warwick | 2018-2030 | "Strong disciplinary identities and excellent will be strengthened by continued investment in digital innovations and evolving facilities for teaching and learning." (The University of Warwick, 2018) |
| University of Bristol | 2015 | "We will continue to invest in successful innovative technology to support learning and teaching." (University of Bristol, 2015) |
| University of Sheffield | 2016-2021 | "Supporting innovation by exploring new ways of teaching, the spaces in which learning takes place, and the technologies we employ." (The University of Sheffield, 2016) |

As shown by these Learning and Teaching Strategies, universities are strongly encouraging widespread embedding of technology across their programmes. This is pushing lecturers to include more and more technology, whether it's using a basic virtual learning environment, in-class voting systems, or going all-out with flipped learning (O'Callaghan et al., 2017; Shelton, 2014). This has several implications. Firstly, this implies that staff are confident, comfortable, and able to educate students using technology, which has been shown to not necessarily be the case (Pierson & Cozart, 2004). Secondly, this push towards digital education may have negative effects for particular groups of students; students with little access to technology, or students who have negative attitudes towards technology such as our stereotypical mature student, will be disproportionately affected. This is why it is important to determine current student attitudes and to respond accordingly.

We have already seen some of the ramifications of increased technology use during the COVID-19 pandemic in 2020, when educators had to rapidly 'pivot' to online teaching (Murphy, 2020; Sullivan et al., 2020). Although a thorough explanation of the effects of the pandemic is outside the scope of this thesis, it is useful to mention as evidence of the effects of online learning and technology use. The pandemic will have long lasting effects on the nature of education, with many institutions providing more digital and online learning opportunities, and may even be a world-changing shift for higher education.

## 2.8 Summary

There is limited research conducted about mature students in higher education and their interactions with and attitudes towards TEL and technology. Studies that do explore the attitudes of mature students to technology are often out of date, frequently dating from more than a decade ago (Czaja & Sharit, 1998; Gardner et al., 1993; Garland & Noyes, 2005), or focus on distance learning rather than traditional face-to-face HE (Jelfs & Richardson, 2013). Furthermore, technology has evolved rapidly, and advances in technology have changed how students learn (S. Kim et al., 2011), and this therefore reduces the applicability of older attitude instruments and scales (Garland & Noyes, 2008). As technology has changed, so therefore will have attitudes and usage (Broady et al., 2010). Studies that have been done more recently that do explore technology attitudes have their own limitations, such as only looking at a single aspect of use like frequency (Kennedy et al., 2010), focussing on mode of study (Arrosagaray et al., 2019), gender (Cai et al., 2017), or being course-specific instead of getting students to reflect on technology use in their everyday lives (Awidi & Paynter, 2019; Edmunds et al., 2012). Other studies are constrained to certain types of technology, such as mobile devices (Al-Emran et al., 2016), or simply computers (Garland & Noyes, 2004).

The cohort in higher education is changing, with increasing acceptance rates for mature students. Universities are expecting lecturers and tutors to integrate technology as widely as possible, and all students are expected to engage with it at an appropriate level (Shelton, 2014). Researchers therefore need to question whether, pedagogically, we should be treating our modern cohort in the same way as cohorts of the past. We need deeper understanding of the technological learning needs of current mature, non-traditional students, and how they are different from those of younger students. We need resources which will be age-inclusive, enable easier integration into the student body, and reduce the non-completion rates of mature students. This understanding is essential for the design of modern pedagogies and TLE resources (Jihyun Lee & Choi, 2017).

# 3 Methodology and Methods

This chapter will discuss the methodology and methods used for planning, conducting, and analysing the study, considering the research design, my design of the instruments, the participants and setting, ethics, and data analysis methods. I will explore the project in the context of a constructivist worldview, and discuss my positionality and insider-outsider status.

## 3.1 Methodology

### 3.1.1 Methodological Approach

I approached this project with a constructivist worldview. I discussed my understanding of constructivism in section 2.2.3, but now I will discuss how it relates to my research project.

My constructivist ontology takes it that each individual has their own internal constructed version of reality, and this is the only access to reality that they have, although it is possible to compare with their ongoing experiences of the world through falsification and communication with others. Epistemologically, this means that individuals' knowledge frameworks are complex and subjective, constantly changing as new elements are either assimilated or rejected according to how they fit (Scaife, 2007). The goal for each individual is to ensure internal consistency, viability, and logical possibility in their own individual reality.

My role as a researcher means that I am an active part of the research. Since reality is internal to each individual, I do not have direct access to others' realities, nor that of an underlying real world. My participants can also only communicate to me their understanding of their reality, and to complicate this even further, this is constrained by their skill in communication, as well as their ability to reflect upon their own knowledge and beliefs. As a researcher, I also have my version of reality and my own cognitive lenses through which I interpret the world. Therefore, during my study, I am co-generating an understanding of participants' views with my participants. This thesis then tells the story of my understanding of that data, which in turn is interpreted by the reader.

As a researcher, I have a certain positionality and certain biases that influence my generation and interpretation of data with my participants. One position I occupy relates to insider-outsider status (Dwyer & Buckle, 2009), which, for my case, is complex. An insider researcher shares the characteristics, roles, or experiences of the participants, whereas an outsider researcher shares none (Dwyer & Buckle, 2009). However, this dualistic presentation is overly simplistic, as the boundaries between insider and outsider status are not clearly defined, and it has been argued that there is an insider-outsider space between them in which a researcher could fall (Dwyer & Buckle, 2009; Merriam et al., 2001).

To some degree, I hold insider status, as I am a mature student. I also teach mature students in a university department. As these students were one of the groups I hoped to be able to involve in my research, I have a peripheral insider status (Dwyer & Buckle, 2009) with these students as a familiar face. I am not, however, one of the students, so in this role, I am an outsider. It was my wish to keep my role as a tutor separate from my role as a researcher with my students to avoid coercion issues. In the future, I would like to expand my research group to include mature students in other institutions, in a variety of international cultural contexts. To these groups of students, I would consider myself even more of an outsider.

The recognition of bias is part of being a researcher; however, separating my biases from my research is impossible and undesirable (Galdas, 2017). Instead, I embrace my own positionality and biases as part of my co-generated data. I have critically examined my own role in the research, and instead of attempting to eliminate bias, I have been reflexive and transparent about my relationship to my participants, my expectations, and my processes (Galdas, 2017).

### 3.1.2 Mixed Methods Within a Constructivist Framework

I chose to use a mixed methods design which incorporates both quantitative and qualitative elements (Denzin, 2012; Greene, 2005; Long, 2015). There is some concern about the conflict between these two methods, particularly surrounding their underpinning worldviews. It is traditionally believed that qualitative methods are associated with interpretivist perspectives, whilst quantitative methods are encompassed within positivist perspectives, although this is beginning to be questioned (Denzin & Lincoln, 2011; Haardörfer, 2019; Y. S. Lincoln & Guba, 2011). Positivism is the belief that there is an objective reality that can be directly observed and about which knowledge can be gained, whereas interpretivism assumes that reality is highly individual or societal in nature, and is generated from our internal mental constructs (Denzin & Lincoln, 2011). Interpretivism is a theoretical perspective situated within the constructivism worldview (Gray, 2017). Positivism and interpretivism are often considered to be two ends of a spectrum, and incompatible, as shown by the 1980s “paradigm war” (Denzin, 2012, p. 21; Tashakkori & Teddlie, 2003).

This therefore raises a question about mixed methods. If it uses both quantitative and qualitative methods, that must mean that it straddles two uncomfortably different perspectives. However, I agree with Shannon-Baker (2016) and Scaife (2019b) that quantitative and qualitative methods are about approaches to data, and mustn’t be used synonymously with positivism or interpretivism. Recent studies are beginning to address the fact that even quantitative data analysis requires some degree of interpretation, and that it needs to move out of a positivist prison (Haardörfer, 2019). There has been some suggestion that worldviews, often called paradigms, are a hindrance to research as they force researchers to accede to and advocate one particular set of beliefs, while being positively xenophobic to others; however, they are a useful tool to guide decisions throughout a project, which is why I have not eschewed them entirely (Shannon-Baker, 2016).

A mixed methods approach research design is particularly suited to a constructivist worldview, since constructivists approach research with an awareness of the multiplicity of knowledge and ways of thinking. This accepts and embraces the confusion surrounding conflicting findings that may arise between quantitative and qualitative aspects of a study (Johnson & Onwuegbuzie, 2004). Mixed methods focuses on meaning-making and encouraging participants to be active in this creation (Denzin & Lincoln, 2011; Long, 2015). Like constructivism, mixed method research is focussed on generating a richer and deeper understanding of phenomena through multiple lenses, perspectives, and realities (Greene, 2005; Johnson, 2012; Tashakkori & Teddlie, 1998).

Mixed methods adds value to findings by enhancing credibility through data triangulation, and elucidating different aspects of the research (Bazeley, 2012; H. B. Weiss et al., 2005). Some researchers suggest that triangulation assumes an external reality, and that triangulation is a positivist attempt to seek a truth (Ellingson, 2009; Hammersley, 2008). However, I see triangulation as seeking a consensus (and identifying where there is no consensus), and therefore not based in implied positivist roots. For me, triangulation is very much compatible with constructivism, in the same was as mixed method research, where the goal is to generate richer understandings. Some authors, such as Ellingson (2009), suggest 'crystallisation' as an alternative to triangulation, where crystallisation combines different analyses and representations to gain a deeper, more complex understanding of a topic; however, crystallisation explicitly recognises that there are difficulties in stating claims about knowledge, and that there is no universal truth to discover, only each person's respective truth. This is also compatible with constructivism, as it is impossible to know whether the researcher's interpretation of a participant's reality matches the participant's interpretation of their own reality. I therefore use the term 'triangulation' when I am discussing ways to maintain trustworthiness since I am seeking consensus and differences, and 'crystallisation' when I am exploring others' realities with no goal to establish a truth.

The weaknesses of mixed methods are primarily based around the researcher: it can be difficult or time-consuming for one researcher to conduct both quantitative and qualitative methods, learning new methods and how to mix them (Johnson & Onwuegbuzie, 2004). However, as a scientist-turned-social-scientist, I am comfortable operating in both quantitative and qualitative domains.

### 3.1.3 Evaluating Constructivist Research: Trustworthiness Criteria

The traditional definitions of internal and external validity and reliability are often associated with a positivist paradigm (Y. S. Lincoln, 1995). Internal validity is a measure of causality, external validity is a measure of generalisability, and reliability is a measure of replicability (L. Cohen et al., 2011; Wellington, 2000). Due to their positivist origins, these quality criteria are not always appropriate for use in certain types of research, such as for qualitative research, or for studies set within a constructivist worldview.

Guba and Lincoln (Guba & Lincoln, 1989; Y. S. Lincoln, 1995; Y. S. Lincoln & Guba, 1985), who work within a constructivist worldview, suggest a number of alternative quality criteria specifically for the qualitative researcher. These parallel criteria are collectively known as “trustworthiness” criteria (Y. S. Lincoln, 1995, p. 277). Although there has been some discussion for other quality criteria for mixed methods (e.g. Collins et al., 2012; Scaife, 2019a), they have not been around as long or been as widely adopted. I have therefore chosen to use the trustworthiness criteria as they are widely accepted within qualitative research (Shenton, 2004), and they work well as convergent criteria, which are criteria that can be applied to both quantitative and qualitative methods (Collins et al., 2012).

Table 3.2.1 details the mapping of the trustworthiness quality criteria onto the traditional quality criteria found in positivism and post-positivism.

**Table 3.2.1**
*Quality criteria in positivism and constructivism, adapted from Bryman et al. (2008) and Lincoln (1995)*

| Positivist quality criteria | Trustworthiness criteria |
|---|---|
| Internal validity | Credibility |
| External validity | Transferability |
| Reliability | Dependability |
| Objectivity | Confirmability |

Credibility looks at the match between the findings of a study and reality (Y. S. Lincoln & Guba, 1985; Shenton, 2004), although working within a constructivist worldview, we accept that we cannot directly access the real world to check this match. We therefore assess our research in terms of whether it is logically possible. Credibility can be achieved by a number of methods: most importantly, by member checking, where participants are invited to check that the researcher is giving a suitable rendition of what they intended to say; other methods include triangulation, extended engagement and observation with participants and the recording of this in thick description, regular peer feedback between researchers, and iterative hypothesis refinement (Guba & Lincoln, 1989; Y. S. Lincoln & Guba, 1985; Shenton, 2004).

Transferability suggests that, instead of being generalisable to a wider population, the findings are applicable to other similar contexts (Y. S. Lincoln & Guba, 1985). As Shenton (2004) explains, the original researcher cannot make a judgement to the transferability of a study, as they only know “the sending context” (Shenton, 2004, p. 70). Only subsequent readers, who have knowledge of other similar situations, are able to judge this criterion. It is therefore important that thick description and explication of context are provided (Y. S. Lincoln, 1995; Y. S. Lincoln & Guba, 1985; Shenton, 2004). Although this seems to indicate that a qualitative researcher can never demonstrate the transferability of their own research, they can take steps to provide the relevant information in order to allow others to make this judgement swiftly and easily. Transparency on the part of the researcher could act as a proxy for transferability, until that can be established. It is also important to note that the transferability will not be perfect, or even guaranteed (Shenton, 2004).

Dependability is broadly similar to its positivist parallel, in that its goal is to examine the consistency and replicability of the findings (Y. S. Lincoln & Guba, 1985). However, reliability is usually a static construct, due to its assertion that the conditions, methods and participants must be the same in order for replicability to be possible (Shenton, 2004). This has severe limitations in an ethnographically-evolving world, where the same conditions may not be possible to replicate. Dependability, on the other hand, explicitly allows for changing circumstances in not expecting an exact replica in results from repeated studies. Instead, an emphasis is placed on detailed and reflective process notes, allowing another to repeat the study and assess the methods (Guba & Lincoln, 1989; Shenton, 2004).

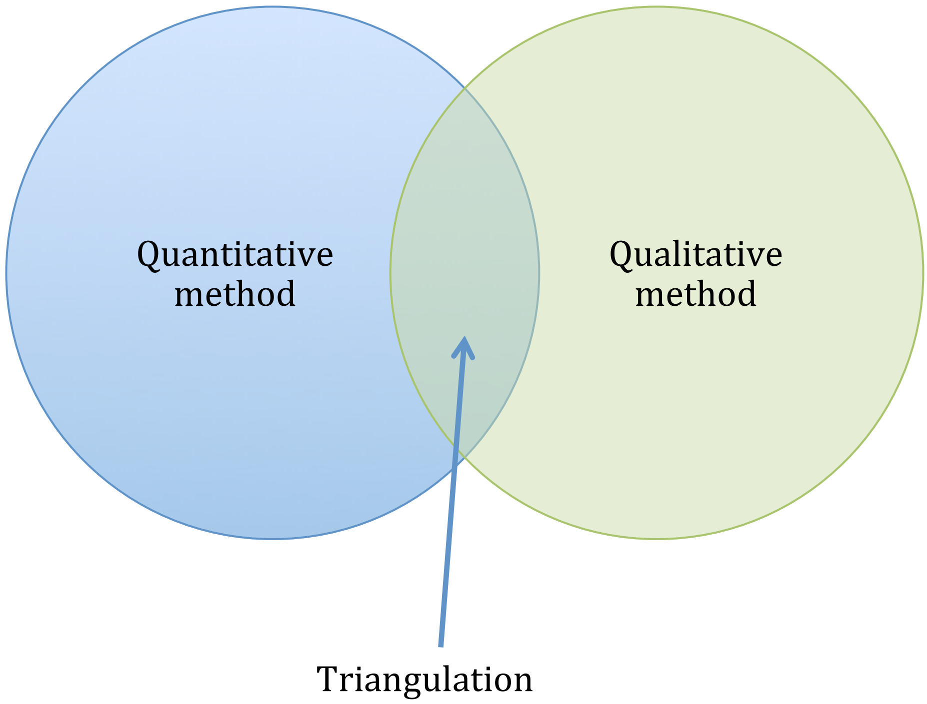
Confirmability is a concept based on ensuring that the participants' contributions are fairly and accurately represented in the study (Guba & Lincoln, 1989; Y. S. Lincoln & Guba, 1985; Shenton, 2004). Ways to maximise confirmability include triangulation, explicit discussion of potential biases and positionality, rationalised decisions on methods, and generally, a detailed, transparent, and reflexive audit trail (Y. S. Lincoln & Guba, 1985; Shenton, 2004).

It is clear that the constructs of credibility, transferability, dependability and confirmability are all inextricably linked, and therefore any steps taken to improve one impacts on the others. This is likely to be in a positive way.

## 3.2 Research Design

This study uses mixed methods, where both quantitative and qualitative methods and analysis are used. Figure 3.2.1 shows my interpretation of how these methods interact. The blue quantitative section indicates findings that are found only from the quantitative methods, whereas the green indicates the qualitative findings. The cyan overlap shows an area where the two methods may confirm each other, be discordant with each other, or expand upon one another (Fetters et al., 2013). The important thing to note is that there are areas where each method finds its own data, and areas where they examine data from a common ground.

**Figure 3.2.1**
*Venn diagram showing how mixed methods interact*




This study presents three research questions, which I have reiterated below. Different methods will be more or less applicable in order to address each research question in turn.

1) How do usage and attitudes to technology and technology-enhanced learning in higher education differ for students of different age groups?

2) What factors affect students' use, attitudes and confidence with technology and TEL, and is there a difference between mature and non-mature students?

3) What are the implications for the design of age-inclusive learning environments in higher education?

Research question one was initially explored through a questionnaire. Questionnaires are commonly used to measure attitudes using attitude scales, insofar as an attitude can be measured (Oppenheim, 1998). Since attitudes are a product of an individual's place in space and time, they may evolve, and therefore an assessment of attitude on a given day may only be credible for a short time, whether a year, a month, or even that day. This has been shown in studies where attitudes are measured before and after a task (e.g. Czaja & Sharit, 1998).

Questionnaires have numerous strengths and weaknesses which are inherent to the nature of the method. According to Wellington (2000), information generated via questionnaire risks being superficial, although I would argue this may only be the case if the questionnaire is poorly designed. A questionnaire may also be used for an initial exploratory phase in a larger piece of research, so what to one author seems superficial may simply be a springboard for later phases. Further, in a mixed method design, it is common to use a questionnaire to form a basis for a study, or to add a layer of representativeness, and then conduct interviews, observations, or other methods to delve deeper into a fewer number of respondents (Bazeley, 2012; Wellington, 2000).

A major disadvantage to questionnaires is that if a participant misunderstands a question, fails to follow instructions, or misreads a phrase, there is no way for the researcher to know (Vehovar & Manfreda, 2008). There are a number of deliberate and non-deliberate acts participants do that can likewise reduce the response quality of questionnaire data. These include not responding to certain items, always choosing the midpoint response, speeding (rushing through the questionnaire, producing less thought-through or random answers), straight-lining (choosing the same answers in a straight line down the page), and giving short open-text responses (Andreadis & Kartsounidou, 2020). It is also common for students to “satisfice” (Revilla et al., 2017, p. 1321), which is choosing the first acceptable answer rather than thinking which is the best answer, in order to reduce the effort required for the questionnaire; this may also be the reason behind midpoint respondents, speeders, and straight-liners. Satisficing is particularly common for questionnaires that offer a reward for completion (Revilla et al., 2017).

Although questionnaires can allow qualitative answers through open-text comments, they are most often used to generate quantitative data. This makes analysis relatively straightforward as the data is simpler in nature (Wellington, 2000). As well as quantitative parts, I chose to include one optional open-text comment in my survey asking if students wanted to comment further on their responses, since some students like to write. This added an extra level to my data.

I chose to use a web questionnaire as it is a convenient method of rapidly sampling a large number of participants (Wellington, 2000). However, web questionnaires, as opposed to paper-based questionnaires, have certain drawbacks. Participants don’t have the eye-hand centralisation that they would when completing paper questionnaires (Vehovar & Manfreda, 2008), which makes the questionnaire slightly more difficult for participants to complete, and requires adding sections with regular repeated headings throughout the questionnaire. Internet users also usually engage less thoroughly with text than graphics (Vehovar & Manfreda, 2008), again impacting on an optimal design. However, I judged that these were relatively minor issues that could be largely addressed through careful design, and therefore chose to use a web questionnaire due to its advantages of convenience and ease of distribution.

For the second stage of my project, I chose to interview a sample of participants who completed my questionnaire. The interview data was expected to feed primarily into research question two about what factors affects students’ use, confidence, and attitudes to technology and TEL, but also to add crystallisation and depth to research question one about what those attitudes are in the first place for different ages of student (Wellington, 2000). I expected the interviews to allow my participants to expand upon some of their answers, and that I would be able to generate a greater depth of insight into the reasoning behind their attitudes.

Qualitative interviews are an invaluable part of research, particularly mixed methods, as they "reach the parts which other methods do not reach" (Wellington, 2000, p. 72). Their aim is not to find the truth of a situation, but to explore participants' perspectives and potential multiple realities (Wellington, 2000), which is why interviews are so essential for research conducted within a constructivist worldview. I chose to use semi-structured interviews, which meant I had an interview protocol to guide the interview, but I also allowed space for participants to expand upon their opinions, for me to ask follow-up questions, and otherwise enable flexibility (Coiro et al., 2014; Knox & Burkard, 2009).

One disadvantage of interviews is that sometimes the participant won't feel comfortable talking to the interviewer (Knox & Burkard, 2009). Face-to-face interviews, rather than doing them over the phone or Skype, may also decrease forthcomingness as the participant feels less anonymous, while also potentially increasing interview effects such as response bias caused by interpreting the interviewer's body language as judgement of the acceptability of their answers (Knox & Burkard, 2009). This can then cause differences in what the participants say they do, and what they actually do (Coiro et al., 2014). In order to mitigate these problems, I planned to allow plenty of time for each interview, and to allow my participants to chat off topic if the conversation headed naturally that way in order to establish relationships and empathy (Coiro et al., 2014). Choosing to conduct my interviews face-to-face also helped me to build rapport, as well as generating better quality data (Knox & Burkard, 2009).

Following the design of the questionnaire and interview protocol, I piloted my instruments in order to maximise credibility and trustworthiness (Rattray & Jones, 2007; Sampson, 2004). Pilots are small-scale versions of a study that act as a trial run, and are useful to check the feasibility and quality of the chosen methods and instruments for the main study; changes can then be made accordingly based on pilot feedback (Y. Kim, 2011; Rattray & Jones, 2007). I planned to conduct two stages of a pilot. Initially, I would administer the questionnaire and subsequent interview to colleagues and family, where both myself and my pilotee checked for leading questions, biased language, overly-closed questions, and unclear questions. After any revisions were made in this stage, I moved on to my second phase. This is where I conducted pilots for both the questionnaire and interview with members of my target population (Rattray & Jones, 2007), and these shall be discussed in more detail in section 3.6.

Both the questionnaire and the interview data will inform my discussion for research question three. This will integrate key findings from research questions one and two and consider explicitly how students' attitudes and age differences affects our design of age-inclusive learning environments in higher education.

This section will use an inferential design, focussing on the application of the findings (Nastasi et al., 2010).

My mixed methods, a questionnaire followed by an interview, uses an explanatory sequential design. This is where quantitative data is generated first, and then qualitative data is generated to enrich the account of the findings from the quantitative stage (Fetters et al., 2013). This is the most common form for mixed methods analysis (Bazeley, 2012). Integration is achieved through a connecting approach, where the quantitative survey and qualitative interview datasets are linked throughout sampling. For my study, my interview sample is taken from the sample of students who participated in my questionnaire, and is therefore connected. Further integration occurs from a building approach, as my questionnaire questions informed my choice of interview questions. Lastly, I also use a merging approach, where the quantitative and qualitative analyses, done separately, are then analysed together as a whole (Fetters et al., 2013). Although my results chapter uses a contiguous approach, where the quantitative and qualitative results are presented separately, in my discussion, I will present them jointly. This allows me to assess the coherence of the two types of data, and whether they confirm each other, are discordant with each other, or expand upon one another (Fetters et al., 2013).

## 3.3 Participants and Setting

Teddlie and Tashakkori (2009) suggest that for mixed methods research, a mix of sampling strategies and types for different parts of the study is normal and acceptable. This study is no exception, as it uses sequential mixed methods sampling, where subsequent samples are influenced by preceding samples (L. Cohen et al., 2011; Teddlie & Tashakkori, 2009). In this study, a survey was administered, and participants from the survey were invited to volunteer to participate in follow-up interviews.

Participants were drawn from the population of students in a Russell Group university in the North of England where I teach. An invitation to participate in the questionnaire was circulated to the student volunteers mailing list within the University. This is a mailing list specifically designed to distribute surveys and gather feedback from the entire student body, from undergraduates to PhD students. Students can withdraw from this mailing list at any time. I chose to invite students from my own institution since my experiences that led me to have an interest in this topic arose from teaching students from my institution. There was also an element of convenience in not having to contact external institutions.

My study therefore uses a non-probability sample, where my sample does not necessarily represent the wider population of students across the entire UK, but is potentially representative of similar populations (L. Cohen et al., 2011). There are a wide variety of different types of student, mature and otherwise, in higher education, further education, and colleges, and even within HE, there may be differences in student cohorts between post- and pre-1992 universities. I do not intend to draw conclusions about the entire population of students, but my results may be transferable to similar cohorts.

**Table 3.3.1**

*Overview of participant contact throughout the main research process*

| Contact | Summary |
|---|---|
| Email sent to the student volunteers mailing list with an invitation to participate in a survey (Appendix F) | • Details of the purpose of the study and what the study would involve<br>• Details of the prize draw<br>• Link to the online questionnaire<br>• Ethics summary (withdrawal etc.)<br>• Link to the information sheet<br>• Details on how to contact me or my supervisor<br>• Opportunity for participants to give their email address for follow-up interviews |
| £10 Amazon voucher sent to two questionnaire participants, chosen by random number generator | • Thanks for participating in the questionnaire<br>• Informing them they have won |
| Email sent to questionnaire participants who had provided their email address for a potential follow-up interview (Appendix G) | • Thanks to participant for completing the questionnaire<br>• Details of the purpose of the interview and what it would involve<br>• Details of the prize draw<br>• Link to a Google Calendar appointments page where potential participants could book a slot for their interview<br>• Link to the information sheet<br>• Details on how to contact me or my supervisor |
| Reminder email sent to participants who gave their email address for follow-up interviews but hadn't responded (Appendix H) | • Reminder that slots would be available after the exam period (as interviews were currently being held within that period)<br>• Details what the interview would involve<br>• Details of the prize draw<br>• Link to a Google Calendar appointments page where potential participants could book a slot for their interview<br>• Link to the information sheet<br>• Details on how to contact me or my supervisor |
| Confirmation email sent to participants who had signed up for interview slots (Appendix I) | • Thanks for participating in an interview<br>• Confirmation of the data, time and location of the interview (including a map)<br>• Details on how to change time slot |
| Interview | • Hard copy of information sheet given to each participant<br>• Two consent forms signed by each participant and myself<br>• One consent form given to the participant<br>• Conducted interview<br>• Thanks for volunteering |
| £10 Amazon voucher sent to one interview participant, chosen by random number generator | • Thanks for participating in the interview<br>• Informing them they have won |

In addition, my sample was a volunteer sample (L. Cohen et al., 2011), since the participants were volunteers from the student volunteers mailing list. The sample for the follow-up interview was drawn from respondents who volunteered to be involved further. Since I was inviting participants from my own institution for convenience, my sampling method also included elements of convenience sampling. Volunteer samples potentially have issues arising from the volunteers having specific and unanticipated motives for responding which may affect the results (L. Cohen et al., 2011). There may also be some bias in contacting students by email when the study is about attitudes to technology, since students who have negative attitudes to technology may be less likely to look at their emails, or to do an online questionnaire. However, this was deemed unlikely to have a large effect, since all students in my target institution are explicitly expected to engage with their emails, and to fulfil course obligations through VLEs, etc. I could also have targeted less-confident technology users specifically in order to mitigate for this effect, and although I considered doing this, it felt disingenuous as I wasn't able to offer them anything.

As I wanted to compare attitudes and factors across different age groups, it was important that a substantial number of mature students be included in the sample. I considered targeting mature students in a second email to the student volunteers list, however an appropriate number of mature students responded to the original survey, so this was not necessary.

The process of contacting participants is summarised in Table 3.3.1.

## 3.4 Questionnaire Design

My goal was to find a questionnaire that asked students about their attitudes to technology and TEL. I primarily expected the questionnaire to answer my first research question, "How do usage and attitudes to technology and technology-enhanced learning in higher education differ for students of difference age groups?".

I reviewed a number of existing instruments to see if I would be able to use any as they stood, or with modifications. I began by doing a semi-systematic literature review using the Google Scholar database. I limited my search to the ten years spanning 2006 to 2016 (the year in which the literature search was done). This was to try and find more recent instruments, since technology is a fast-evolving topic, and I judged that anything much older than 10 years would be significantly out of date. I used the search terms "attitude(s)", "technology" and "instrument(s)", since I was primarily interested in pre-existing instruments exploring technology attitudes. I only considered English-language articles and instruments, as I do not speak any other languages sufficiently well.

It is possible I missed some instruments by not using a broader range of search terms, such as including "questionnaire" instead of "instrument". However, I did a brief check search using the term "questionnaire" instead of instrument, and it did not seem to give different results than using "instrument", so I don't believe the results were majorly affected. It is possible I also missed instruments that are specific to one type of technology; however, I was looking for an instrument about technology more broadly, hence my choice to use the generic term "technology" instead.

The search yielded a number of different studies from the ten-year time frame. Several of these studies had used older instruments. I included these older instruments in my review since they had been accepted for use within the chosen time period, and were therefore judged by researchers and peer reviewers to represent sufficiently the recent technological landscape.

From the search results, any studies or instruments that didn't have attitudes as their focus were disregarded, even if the instrument did have one or two attitude-related questions. Only studies about the attitudes of students were considered; this included students studying on teacher-training courses, where the trainee teachers were the focus rather than their prospective pupils. Any studies that were about child-specific instruments that weren't adult-compatible were also rejected, since my study focuses on the use of technology by adults. The majority of questions in the instruments considered were Likert-style items.

The instruments I considered are summarised in Table 3.4.1. After looking through each of these instruments, I found that none was suitable in its entirety for the present study. The CAQ (Knezek et al., 1998) focussed more on attitudes to computers compared to television, books and writing, as did the BAC (Garland & Noyes, 2005) questionnaire, and had an out-of-date focus on e-mail. The CAQ, BAC, ATCQ (Jay & Willis, 1992) and mobile learning questionnaire (Al-Emran et al., 2016) were all too narrowly-focussed in the single technology they were examining, being computers for the first three, and mobile technology for the latter. Many of the instruments simply seemed out of date, as older scales to attitudes of computers and technology tend to require updating, and may no longer reflect upon the contemporary technological context or attitudes towards it accurately, thereby reducing their credibility (Garland & Noyes, 2008).

I therefore chose to design a new questionnaire to sufficiently address my research questions. My new questionnaire was named the Technology Attitudes Questionnaire (TAQ).

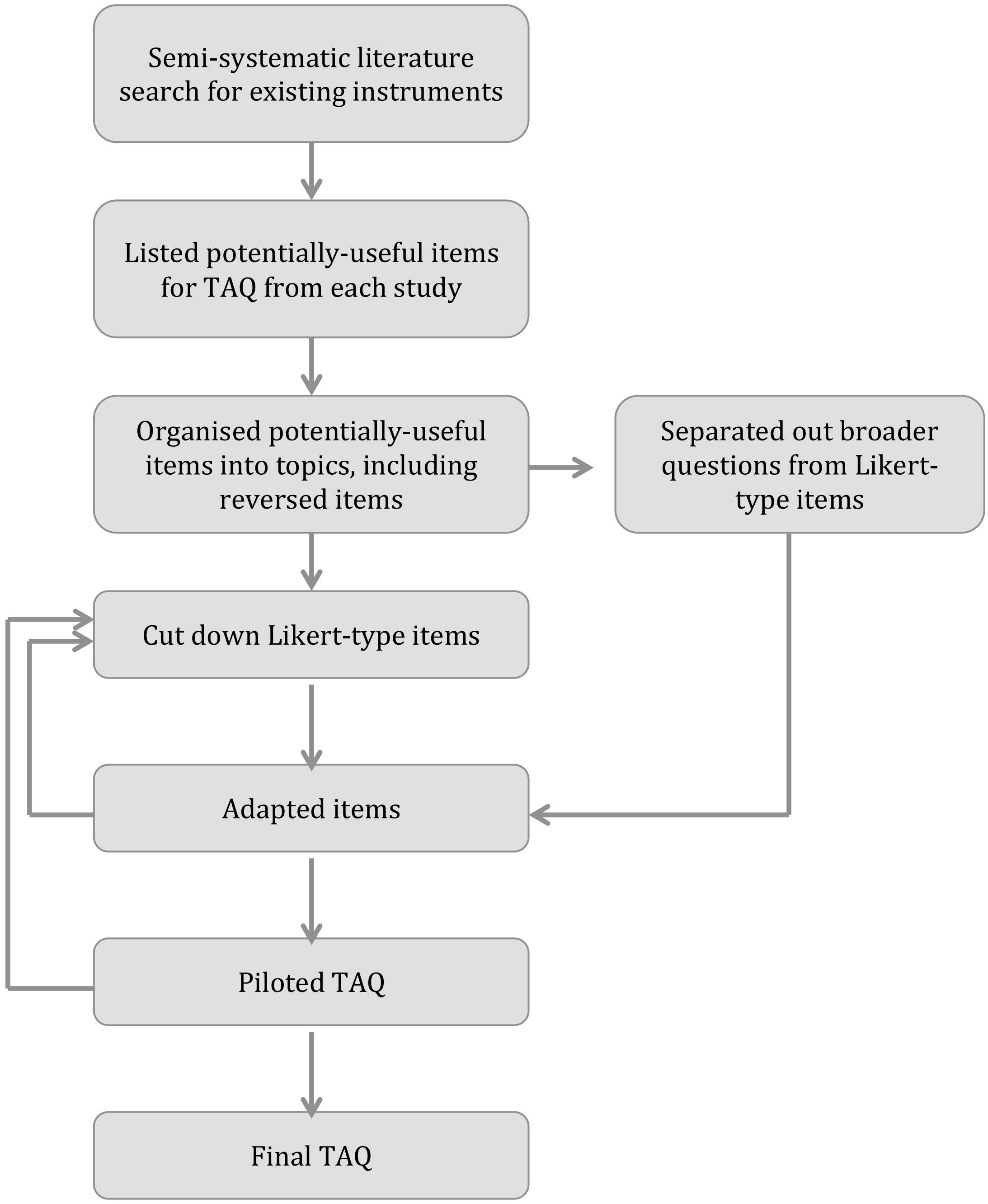
Despite these shortcomings of the pre-existing questionnaires, each had items that guided the new questionnaire instrument. I also very quickly scanned through alternative instruments that I had previously rejected in my search, to ensure there were no large swathes of possible question areas I had missed. I made a list of useful items from the existing instruments, organising them into the following topics (within each topic were also any reversed items): usefulness; like/enjoyment; ease; confidence; interest; support; importance; control; familiarity; and miscellaneous items. Table 3.4.1 shows how many items were taken from each instrument for initial consideration. Figure 3.4.1 shows the process by which I created the TAQ.

I initially considered 265 Likert-style items to potentially include in the TAQ (see Table 3.4.1). In the first iteration of reducing items, I removed items if they were duplicates, very similar to each other, or unclear. I also removed them if they were difficult to adapt to be about general technology, as quite a few items were about specific technologies such as computers or mobile phones. After this process, I was left with 57 items.

**Table 3.4.1**
*Number of potential items for the TAQ, initially taken from instruments found by a semi-systematic literature search*

| Study | Summary | Number of items |
|---|---|---|
| Knezek, Christensen, & Miyashita, 1998 | Computer Attitude Questionnaire (CAQ) | 27 |
| Garland & Noyes, 2005 | Books and Computers Questionnaire (BAC) | 24 |
| Al-Emran, Elsherif, & Shaalan, 2016 | Survey towards mobile learning attitudes | 6 |
| Jay & Willis, 1992 | Attitudes Towards Computers Questionnaire (ATCQ) | 31 |
| Bonanno & Kommers, 2008 | Survey investigating gender influences on gaming attitudes | 19 |
| Edmunds, Thorpe, & Conole, 2012 | Technology Acceptance Model (TAM) | 19 |
| Lee & Clarke, 2015 | Shortened version of the Information Technology Attitudes Scale for Health (ITASH) | 12 |
| Liaw, Huang, & Chen, 2007 | Survey examining instructor and student attitudes towards e-learning | 9 |
| Nguyen, Hsieh, & Allen, 2006 | Survey examining the effects of web-based assessments and practice on learning attitudes | 10 |
| Pierce, Stacey, & Barkatsas, 2007 | Mathematics and Technology Attitudes Scale (MTAS) | 4 |
| Porter & Donthu, 2006 | Extended Technology Acceptance Model (TAM) | 15 |
| Roca, Chiu, & Martínez, 2006 | Extended Technology Acceptance Model (TAM) | 16 |
| Saadé & Kira, 2007 | Survey examining the influence of anxiety on perceived ease of use of computers | 12 |
| Sagin Simsek, 2008 | Survey investigating students' attitudes to use of ICT | 23 |
| (Teo et al., 2008), adapted from Davis, 1989 | Extended Technology Acceptance Model (TAM) | 18 |
| (Teo, 2008) | Survey examining computer importance, enjoyment and anxiety | 20 |
| Total | | 265 |

**Figure 3.4.1**
*Workflow for the creation of the Technology Attitudes Questionnaire (TAQ), showing the iterative process of choosing the questionnaire items*



Since I wanted the questionnaire to be about technology generally, with the interview potentially exploring specific technologies in more detail, I adapted the 57 items by replacing all references to specific technologies with just "technology". I rephrased ambiguous sentences, and made statements as simple as possible. I then reviewed my items again, and cut them down a second time. If any items were too similar after adaptation, or were unsuccessfully adapted, they were removed. This resulted in 51 items being used for the pilot TAQ. The Likert-style items covered aspects of enjoyment, usefulness, confidence, interest, ease of use, support, and importance. The items included both positive and reversed items in an attempt to combat acquiescence bias (Oppenheim, 1998).

Fifty one items seemed like it might be too many items for the questionnaire as it would take participants too much time and be too tedious without actually adding anything to the data, so I considered doing another round of cutting items. However, since I did not have a clear idea of which items would be the best for the TAQ, I decided to leave all 51 in the questionnaire and cut them further after piloting based on feedback and analysis (Oppenheim, 1998). Section 3.6 will discuss my piloting process further. After piloting, the attitudes section of the TAQ included 35 items.

The TAQ (see Appendix A) is divided into four main sections. The TAQ uses a funnel approach, which involves starting with broad questions, then narrowing them down to be more specific (Oppenheim, 1998).

The first page of the questionnaire as participants enter thanks them for participating in the questionnaire, advises them they may withdraw at any time without reason by closing the window, and gives my email address for any questions. It then asks participants to give their informed consent using the university's standard consent criteria: confirming they have read the information sheet and have had the opportunity to ask questions; confirm that participation is voluntary and that they understand they may withdraw or not answer a particular question; confirm that they understand how their information will be used; agree that the data can be used for future research; and agree to participate in the project. Participants are not permitted to progress with the questionnaire unless they give their consent for these five conditions.

Since whether students use technology for home or for educational use is a factor that affects attitudes (Garland & Noyes, 2004; Levine & Donitsa-Schmidt, 1998), my aim was to find out which technologies were used for home or institutional activities, which would help me to answer my second research question. I was interested in learning how the technologies they used in their everyday lives outside formal education ("non-course activities") were different from those they used on the courses ("course activities"). This was important for me due to conversations I have had with my students where they tell me they are not comfortable with technology and struggle to use it, but then shortly after our conversation, they take out their smartphone and confidently use Facebook. Section one, therefore, asks students which technologies they have ever used for more than a 'sample session', and whether this has been for course activities, non-course activities, or both. This is done in a list format, where the list is comprised of 24 different technologies.

The technologies chosen for the list were initially taken from the literature I had previously found on technology use and technology attitudes, and included a variety of different technologies often used in education and educational research. To this, I added technologies I had used in my own education or teaching, and those that I had heard colleagues speak about using. Software packages such as word processors, spreadsheets, and presentation software were collapsed into one descriptor of "office suite". Interactive whiteboards, which were found from the literature, were removed as they were not a type of technology that students themselves used per se, especially not for non-course activities. Although there is a very large number of technologies that could be added to the final list (shown in Table 3.4.2) many of them fall as subcategories to already-chosen items, for example, blogs and vlogs could fall under technologies such as the Internet and social media, so I chose not to include them as their own option. Examples were included for some of the options to make it clear what types of technology fell under each item so the students could generalise more easily. In addition, an "other" option as a free-text box was included so that participants could input their own technologies if they felt that there was anything in particular they used that my list did not cover.

**Table 3.4.2**
*List of technologies provided in the TAQ*

| | | |
|---|---|---|
| Desktop computer | Laptop computer | Tablet computer e.g., iPad |
| Mobile telephone (smartphone e.g., iPhone, Samsung Galaxy | Television | Radio |
| The Internet | MP3 Player e.g., iPod | E-reader e.g., Kindle, Kobo |
| Calculator | Email | Texting |
| Voting mechanism e.g., physical clicks, voting software such as Socrative | Instant messaging e.g., Snapchat, Whatsapp | Video calls and conferencing e.g., Skype, Facetime, Hangouts |
| Social networking e.g., Facebook, Twitter | Office suite e.g., word processors like Microsoft Word, spreadsheets such as Excel, Powerpoint etc. | Videos e.g., YouTube, Netflix, Vimeo |
| Online tutorials e.g., Khan Academy, iTunes U, Coursera, TED | Wiki e.g., Wikipedia, WikiAnswers | Online forums e.g., Reddit, The Student Room |
| Virtual learning environments e.g., [University VLE name] | Quizzes e.g., on the computer, apps | Games e.g., on the computer, apps, consoles |

For section two, I wanted to find out more about students' use of the technologies from section one. I knew that I would be doing follow-up interviews that could be used for many of these types of questions, and that some of what I wanted to ask was not suitable for an online questionnaire format. A number of potential topics and questions were initially drafted based on the literature, and chosen based on the criteria of feasibility to distribute in a questionnaire, and appropriateness for a questionnaire format over an interview. They were then reduced further based on the length of the questionnaire. Rejected items and topics were rephrased into interview questions. In the final version of the TAQ, section two consisted of two questions. The first asks participants how often they currently used the types of technology given in question one, in any form of use, for any length of time. The options given were: "daily"; "weekly"; "monthly"; "less often than monthly"; and "never". These were adapted from the summary frequencies from Kennedy et al. (2010), with their option of "yearly" changed to "less often than monthly" as there seemed to be no frequency option between monthly and yearly. The second question asks participants how long they have been using these forms of technology, in any form or amount of use. The options given here were: less than a year; 1-2 years; 3-5 years; 6-10 years; more than 10 years; and never. These are similar questions to those posited by Garland and Noyes (2004) to measure computer use. This was again designed to answer my second research question on factors affecting attitudes, but students' frequency of use could also be considered part of their attitude for research question one.

Section three explores students' attitudes to technology in general, to answer my first research question on students' attitudes and how they differ across the ages. The attitudes scale was chosen to be about general technology rather than the specific technologies listed in sections one and two because I wanted to investigate students' attitudes to the idea of technology, which in my experience is a more anxiety-inducing concept to students than any single type of technology. I was interested to compare their general technology attitudes with which technologies they have used for course and non-course activities, as non-course activities are chosen for pleasure use by the student, so one might expect a more positive attitude for pleasure activities.

I chose to use Likert-type scales for this attitude section of the questionnaire, since Schwarz et al. (1991) found that questionnaire participants tend to give consistent results when using such rating scales, and it is a well-documented tool for attitude scales. A seven-point scale was chosen, as seven-point scales tend to perform better than five-point scales in terms of dependability; they also give respondents more scope to discriminate between scale values, and reduce the percentage of "neither agree nor disagree"-style midpoint responses (L. Cohen et al., 2011; Schwarz et al., 1991). The responses I used in my Likert-style scale were adapted from Beshai et al. (2013): entirely agree; mostly agree; somewhat agree; neither agree nor disagree; somewhat disagree; mostly disagree; entirely disagree. An eighth option for "not sure/prefer not to answer/not applicable" was also included in order for participants to abstain from a given question. This was included both to avoid forcing an evaluative response and to inform me if any particular questionnaire item was dysfunctional. The Likert-type instrument used a verbal rating scale, as having a label for each scale point has been found to be more dependable than scales that only had endpoint labels (Schwarz et al., 1991). Some of the Likert items were included as reversed items, where a question is asked in the negative (e.g., “I don’t like coffee” instead of “I like coffee”). This was done in an attempt to combat the acquiescence bias that Likert items often encounter, in which participants tend towards agreement with items rather than disagreement (Oppenheim, 1998).

At the end of section three is an optional free-text box that asks participants to input anything else they feel is relevant about their experiences with technology. This was to allow students to write if they wanted, and to generate rich data from spontaneous responses from participants. This may also reduce bias that arose from my chosen items being the only responses (Reja et al., 2003). I considered that this was an invaluable opportunity to potentially generate data with all of my questionnaire participants, since only a small number would eventually be invited to interview, however I decided against making it compulsory, since that may have reduced the completion rate of the questionnaire. I hoped to use some of these responses to begin to answer my second research question, which asked what factors affect students’ use, attitudes and confidence with TEL and technology.

The demographics collected were age group, course discipline (the sciences including maths, social sciences, arts and humanities, engineering, other), and whether study was full time or part time. These three demographics were chosen as I want to analyse the data, and explore how each of these three factors affect students’ attitudes to technology. Demographics such as gender, ethnicity and socioeconomic status were not included at this stage, since this study is not examining their effects on attitudes towards technology. The demographics section was included as the last section in the questionnaire, since the questions are often quite prying, and in order to maintain interest and a good response rate in the questionnaire, these are best put at the end so as to not deter potential participants (Oppenheim, 1998). A short explanation (that the questions are to help me analyse the data) was also included, to help the participant feel like the questions aren’t intruding unnecessarily (Oppenheim, 1998).

Included in the demographics section is an open-text box for participants to provide an email address in order to be contacted for further participation in the study, and, in the non-pilot version of the questionnaire, for rewards. I have included an option to opt-out of the draw for the Amazon voucher reward, as a forced draw might prevent some students from wanting to participate, since it may be considered gambling which is incompatible with some students’ lifestyles and cultures. The email address request was placed on a separate page to the rest of the demographics questions in order to draw attention to the preamble which states that it would be useful if the participant could volunteer for a follow-up interview, explains where the interview will take place, and when the participant can expect to be contacted. It also reiterates that it is optional, and that by giving an email address, the participant is not committing to participating and may withdraw at any time without prejudice.

### 3.4.1 Questionnaire Pilot

I conducted a two-stage pilot for the new questionnaire. The first stage was a pre-pilot, where I invited some friends, family, and colleagues to read through the questionnaire and give feedback on the clarity of the questions, the flow of the questionnaire, how well the questionnaire worked on the SurveyMonkey platform (particularly with regards to sectioning and response format), and the amount of time taken to do the questionnaire. My PhD supervisors and confirmation reviewers also looked over the questionnaire and offered comments.

Each of my pre-pilot volunteers who took the questionnaire spent approximately 20 minutes on it. This was therefore the amount of time needed to participate that I advertised in my invitation email to students. Several questions were clarified or removed based on the comments. The preamble for each question was also changed in accordance with comments.

The second stage of the pilot was conducting the questionnaire with members of my target population. The pilot questionnaire was sent out to the student volunteers mailing list at the university at which I teach. Contrary to the main study, no voucher prize draw was offered for the pilot, as I was interested to see the attrition rate with no incentive. For the pilot questionnaire, I set a response limit of 35 people. This was chosen as I hoped for approximately 20 participants who completed the entire questionnaire, and approximately three participants for follow-up interviews. The pilot limit of 35 therefore allowed for some attrition. Although these numbers would not be sufficient to conduct a rigorous analysis, they were enough to confirm that the questionnaire was usable in the full-scale study. It also allowed me to trial my data generation procedures, such as how I recruited participants, and the communication I had with them.

In total, 35 students began the pilot questionnaire and 24 completed it, giving a completion rate of approximately 69%. Most non-completers stopped the questionnaire at the first question. I presumed this meant that they weren't interested in the types of questions I was asking, but did not judge that anything in the questionnaire needed changing due to that. The pilot questionnaire data was exported from SurveyMonkey in .xlsx format and analysed in SPSS (IBM SPSS Statistics for Mac, Version 22.0). The data was reviewed holistically in the first instance.

All 35 participants who began the questionnaire gave full consent, but had they not, I would have removed all of their data from the dataset. I removed all data from participants who did not complete the questionnaire (11 out of the 35 who began it).

Twenty two out of the 24 participants who completed the questionnaire did so in under 20 minutes. The invitation email told participants that the questionnaire would take approximately 20 minutes to complete, so I was correct in my estimation. I therefore did not reduce the stated time in the invitation email, since, in my experience, it is better to overestimate the time needed to allow participants to put aside enough time to take their time with a questionnaire.

Several participants had chosen "other" as their subject discipline, and had all entered it as "Engineering", or a department within that faculty. I had assumed that Engineering fell under the discipline of "the sciences", but this was incorrect. I therefore added Engineering as one of the subject disciplines for the full-scale questionnaire.

The responses for all questions were exported in string format, so the data (except the open-ended question) was recoded to numerical format in order to allow analysis. Table 3.4.3 shows the coding scheme used for each question. The reversed Likert items had their coding manually reversed. The coding scheme worked well for the pilot, so was retained for the main study with no changes other than an extra numerical code being added for the Engineering discipline.

I ran an exploratory principal components analysis (PCA) with Kaiser normalisation on the Likert data using SPSS. PCA was chosen as a method of factor analysis as it is a reasonably simple analysis while remaining fit for purpose for data reduction (Fabrigar et al., 1999; A. Field, 2005; Matsunaga, 2010).

PCA has a number of assumptions to be fulfilled in order to be credible. The first is that the data is scale data; ordinal data such as Likert scales are often used, but this is considered incorrect, although some authors have found that using ordinal data can give the same results as continuous data, although this comes with its own set of assumptions (Lubke & Muthén, 2009). Since my data was ordinal, the assumption of scale data was violated. This would be a problem for a rigorous analysis, but since I was only using the PCA to 'eyeball' my factor grouping, I was not concerned about being very rigorous. In addition, there is an assumption of linearity between all variables, but this assumption is often relaxed for ordinal data.

Another assumption is that the data should have sampling adequacy, tested by the Kaiser-Meyer-Olkin (KMO) test. Unfortunately, since my correlation matrix was non-positive definite due to having more variables than cases, SPSS was unable to calculate values for the KMO. However, Guadagnoli and Velicer (1988) say that if a factor has at least four loadings greater than 0.6, then regardless of sample size, the factor can be deemed dependable. I initially used Kaiser's eigenvalue-greater-than-one "K1" rule (Fabrigar et al., 1999; Kaiser, 1960) to determine the number of factors, which gave 10 factor components. Out of those 10 components, only some had four loadings greater than 0.6, although those that did not were close. For the purposes of this initial exploration of my very small pilot dataset, I disregarded this assumption.

In addition to having adequate sampling, data should be suitable for data reduction. This is usually tested with Bartlett's test of sphericity, however due to my matrix being non-positive definite, SPSS could not compute this. However, one can manually check the correlation matrix for variables that have very low correlations with all other variables (A. Field, 2005), and when I did this, there were no variables of this type. Therefore my data was suitable for data reduction.

**Table 3.4.3**

*Coding scheme for questionnaire data, converting string data to numerical data*

| Question | String data | Numerical code |
|---|---|---|
| Which technologies have been used for course or non-course activities | I have used this for course activities | 1 |
| | I have used this for non-course activities | 2 |
| | I have used this for both course and non-course activities | 3 |
| | I have not used this / pass | 4 |
| How often these forms of technology are currently used | Daily | 1 |
| | Weekly | 2 |
| | Monthly | 3 |
| | Less often that monthly | 4 |
| | Never | 5 |
| Length of time using these forms of technology | Less than a year | 1 |
| | 1-2 years | 2 |
| | 3-5 years | 3 |
| | 6-10 years | 4 |
| | More than 10 years | 5 |
| | Never | 6 |
| Likert items | Entirely disagree | 1 |
| | Mostly disagree | 2 |
| | Somewhat disagree | 3 |
| | Neither agree nor disagree | 4 |
| | Somewhat agree | 5 |
| | Mostly agree | 6 |
| | Entirely agree | 7 |
| | Pass | Removed |
| Age bracket | 0-17 | 1 |
| | 18-21 | 2 |
| | 22-25 | 3 |
| | 26-30 | 4 |
| | 31-40 | 5 |
| | 41-50 | 6 |
| | 51-60 | 7 |
| | 61-70 | 8 |
| | 71+ | 9 |
| | Prefer not to say | 10 |
| Subject discipline | The sciences (including maths) | 1 |
| | Social sciences | 2 |
| | Arts and humanities | 3 |
| | Engineering | 4 |
| Part time or full time | Full time | 1 |
| | Part time | 2 |

The last assumption is that there are no outliers, which can be described as data that are more than three standard deviations away from the mean. I checked the descriptive statistics output on SPSS, and none of my variables were outliers.

Having explored the assumptions, and found that my data violates some of them, I decided to use it for an initial rough look at my data anyway. A PCA also produces some outputs, such as the correlation matrix, that are useful to have in order to reduce the data, even without the components part being taken into account.

After initially running the PCA, I examined the correlation matrix, and determined which pairs of items had correlations greater than 0.8. This indicates possible multicollinearity in the data (A. Field, 2005). As PCA uses Pearson's coefficient, which is most suitable for scale data, I also ran a separate Spearman's correlation, which is used for ordinal data, in order to compare the results. The pairs of highly-correlated items were very similar, with only two items that were correlated using Pearson's coefficient but not Spearman's. Once the pairs had been identified, I ran a dependability analysis in order to determine whether the removal of any of the items would reduce or improve the Cronbach's Alpha of the entire questionnaire. There were no items that would dramatically reduce or increase the questionnaire dependability should they be deleted, so this did not affect my decisions about which items to keep or remove in the above correlations. For each pair of items, I applied a set of criteria to decide which to keep and which to discard. I checked that the pairs of highly-correlated items were asking about similar concepts, which they all were; this was useful as it meant that I could remove either without losing the ability to probe important concepts. Where multiple items were highly correlated with the same item, I kept the single item and removed the others, since there was little need to keep many items looking at exactly the same concept. For the other pairs, I opted for the more simply-worded or clearer statements (Oppenheim, 1998). In the interests of cutting down my Likert items, I chose to remove the items that were only highly-correlated using Pearson's coefficient, in addition to those shared by both Pearson's and Spearman's.

After this reduction, I was left with 37 items. I created a new dataset with the data from just these 37 items remaining. As part of the iterative process of data reduction, I ran a further PCA. I previously used the K1 rule, giving 10 factor components. However, the K1 rule overestimates the number of factors (Zwick & Velicer, 1986), which may result in the splitting of factors, and potentially giving too much importance to trivial factors (O'Connor, 2000). I therefore instead looked at the scree plot to try and decide on the number of factors to extract (Fabrigar et al., 1999). Scree plots, however, are highly subjective (Ledesma & Valero-Mora, 2007), and this one (see Figure 3.4.2) proved difficult to interpret since, to my eyes, there were two potential points of inflection, one suggesting three factors and one suggesting five. In fact, having multiple inflection points is not uncommon for scree plots (O'Connor, 2000), which I view as a major disadvantage of their use.

**Figure 3.4.2**

*Pilot: PCA scree plot from SPSS for 37-item attitude section*

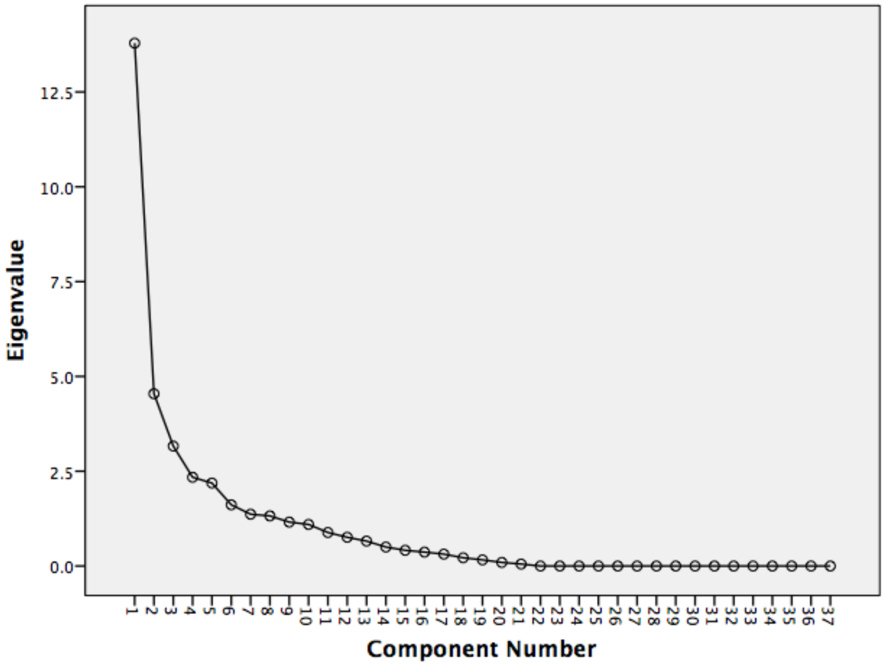



**Figure 3.4.3**

*Pilot: PCA scree plot from rawpar.sps for 37-item attitude section*

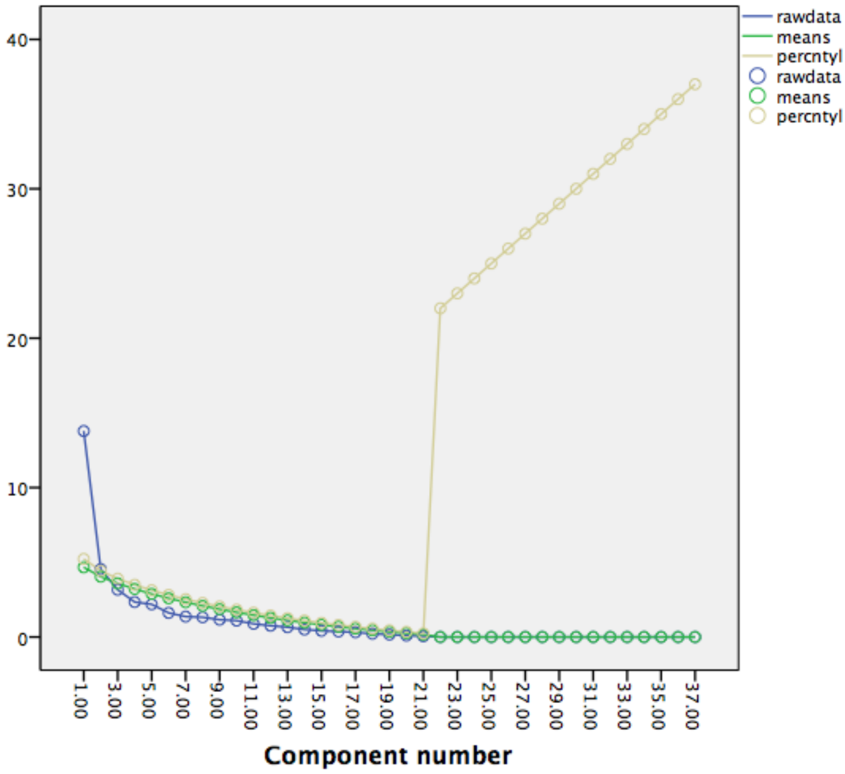


**Table 3.4.4**
*Pilot: Raw data eigenvalues, and mean and 95th percentile data eigenvalues from random permutation*

| Root | Raw data | Means | Percentile |
|---|---|---|---|
| 1.00 | 13.79 * | 4.67 | 5.23 |
| 2.00 | 4.54 * | 4.04 | 4.44 |
| 3.00 | 3.16 | 3.59 | 3.91 |
| 4.00 | 2.34 | 3.21 | 3.49 |
| 5.00 | 2.19 | 2.88 | 3.13 |
| 6.00 | 1.61 | 2.59 | 2.82 |
| 7.00 | 1.37 | 2.33 | 2.53 |
| 8.00 | 1.32 | 2.08 | 2.28 |
| 9.00 | 1.16 | 1.86 | 2.05 |
| 10.00 | 1.10 | 1.65 | 1.83 |
| 11.00 | 0.88 | 1.46 | 1.63 |
| 12.00 | 0.76 | 1.28 | 1.44 |
| 13.00 | 0.66 | 1.11 | 1.26 |
| 14.00 | 0.50 | 0.96 | 1.10 |
| 15.00 | 0.41 | 0.82 | 0.95 |
| 16.00 | 0.37 | 0.68 | 0.81 |
| 17.00 | 0.31 | 0.56 | 0.68 |
| 18.00 | 0.22 | 0.45 | 0.56 |
| 19.00 | 0.16 | 0.35 | 0.44 |
| 20.00 | 0.09 | 0.25 | 0.34 |
| 21.00 | 0.05 | 0.16 | 0.24 |
| 22.00 | 0.00 | 0.00 | 22.00 |
| 23.00 | 0.00 | 0.00 | 23.00 |
| 24.00 | 0.00 | 0.00 | 24.00 |
| 25.00 | 0.00 | 0.00 | 25.00 |
| 26.00 | 0.00 | 0.00 | 26.00 |
| 27.00 | 0.00 | 0.00 | 27.00 |
| 28.00 | 0.00 | 0.00 | 28.00 |
| 29.00 | 0.00 | 0.00 | 29.00 |
| 30.00 | 0.00 | 0.00 | 30.00 |
| 31.00 | 0.00 | 0.00 | 31.00 |
| 32.00 | 0.00 | 0.00 | 32.00 |
| 33.00 | 0.00 | 0.00 | 33.00 |
| 34.00 | 0.00 | 0.00 | 34.00 |
| 35.00 | 0.00 | 0.00 | 35.00 |
| 36.00 | 0.00 | 0.00 | 36.00 |
| 37.00 | 0.00 | 0.00 | 37.00 |

*Note*. * denotes where raw data eigenvalue is larger than the eigenvalue of the 95th percentile – statistically significant at the 0.05 significance level

Instead of using the scree plot, therefore, I instead used Horn's parallel analysis (PA) in order to determine how many factors to extract (Horn, 1965). Parallel analysis consistently outperforms both the K1 rule and scree plots, and is considered the most accurate method of factor extraction (Ledesma & Valero-

Mora, 2007; Matsunaga, 2010; O'Connor, 2000; Zwick & Velicer, 1986). Parallel analysis compares the eigenvalues of the real data with Monte Carlo simulations that simulate random data matrices of the same size as the real data. Although SPSS has no built-in capability to do a parallel analysis, I ran O'Connor's (2000) rawpar.sps program in SPSS syntax in order to do the analysis. In addition to comparing the data eigenvalues to normally-distributed random data, this program has the ability to generate random permutations of the raw data set to which to compare the eigenvalues. This is useful for data that is not normally-distributed, and is therefore more robust. This is what I used to generate the Monte Carlo simulation. The analysis was run over 5000 simulations, with eigenvalues corresponding to the 95% percentile (22 cases, 37 variables). The results are shown in Table 3.4.4. The program also produces a scree plot, shown in Figure 3.4.3, where it is easier to see the point of inflection. However, I have used the Table results to determine the number of factors.

The parallel analysis results shown in Table 3.4.4 suggests that two factors should be retained, as there are two values where the raw data eigenvalue is larger than the eigenvalue of the 95$^{th}$ percentile.

I then ran another principal component analysis on this dataset to investigate the components present, restricting the number of factors to two. I used an oblique direct oblimin rotation rather than an orthogonal rotation, since oblique rotations allow for factors to be correlated, while orthogonal rotations assume factors are uncorrelated. My factors are highly unlikely to be completely uncorrelated, and therefore forcing orthogonality on the components may result in distorted results; should the factors actually be uncorrelated, this will be shown by the oblique rotation (Costello & Osborne, 2005; Matsunaga, 2010). According to Tabachnick and Fidell (2007), if the correlation between two factors is greater than 0.32, an oblique rotation should be used. Using SPSS, I found that the correlation between the two factors in this sample was 0.319. Since this rounds to 0.32, above which one assumes correlation rather than uncorrelation, I continued with the oblique rotation since I could not justify saying that the factors would be uncorrelated. Direct oblimin rotation was chosen over promax, although SPSS offers both oblique rotations, as promax adapts its results from an orthogonal rotation, but direct oblimin uses the initial factors directly. In reality, the difference in results between them tends to be small (Robins et al., 2009).

The rotated component pattern matrix given by the PCA was scrutinised. Oblique rotations give two matrices: a pattern matrix, containing the loadings on each factor, and a structure matrix, containing the correlations between the items and the factors. For the purposes of determining the items to keep, the pattern matrix of loadings was used. Items with loadings smaller than 0.4 on all factors were discarded (Matsunaga, 2010), and this resulted in three items being removed. Furthermore, two items loaded onto both factors with a difference of less than 0.4 between the primary and secondary loadings. These were also discarded (Matsunaga, 2010). This resulted in 31 attitude items remaining.

Another PCA was run with the remaining 31 items. The rotated pattern matrix with direct oblimin rotation and Kaiser normalisation, with suppression of component loadings less than 0.4, is shown in Table 3.4.5. Table 3.4.6 shows the structure matrix, again with direct oblimin rotation and Kaiser normalisation. These items and factors were reviewed to ensure that the item groupings made theoretical sense (Matsunaga, 2010). This was challenging since there were 18 items in factor one and 13 items in factor two, so the breadth of each factor makes it difficult to interpret. Initially, however, my broad interpretations are of factor one being about one's use of technology, and factor two being about comfort and confidence in oneself when using technology. There is one item ("Technology makes me uncomfortable") that loads onto factor one when it seems like it should load onto factor two, according to my interpretation. This was not removed, since it is possible that a participant's interpretation of this item could be towards "I don't use technology", rather than strictly comfort. The retention of this item means that the final attitude instrument is made up of 31 Likert items, the rotated component matrices of which are shown in Tables 3.4.5 and 3.4.6.

The component correlation matrix shown in Table 3.4.7 now indicates correlations of greater than 0.32, which confirms that an oblique rotation was the correct rotation to use.

Some of my reversed items were removed in the course of reducing the items. The final attitudes section has 13 reversed items, and 19 positive items. I considered reversing some of the remaining positive items in order to make the number of reversed and positive items equal, in order to combat participants tending towards the 'positive' end of the answer spectrum. However, since the number of positive and reversed items are not hugely different, I decided to not change any items as I would have wanted to do another pilot to determine if the changed items had similar credibility.

Overall, this section three of my questionnaire, which looks at students' attitudes towards technology, had a Cronbach's alpha of 0.935 over 31 items which indicates a high level of internal consistency and dependability. This coefficient is sufficiently high, and above the minimum recommendation of 0.7 (Nunnally & Bernstein, 1994). It is common for tests with higher numbers of items to result in higher levels of alpha (Tavakol & Dennick, 2011), so the relatively high number of items in this test may explain why alpha is so high. It may also be a result of unidimensionality, but the PCA run suggests that this is not the case (Tavakol & Dennick, 2011).

**Table 3.4.5**
*Pilot: Rotated component pattern matrix from PCA with direct oblimin rotation and Kaiser normalisation; rotation converged in 9 iterations*

| | Component | |
|---|---|---|
| | 1 | 2 |
| The use of technology makes a course more interesting | .861 | |
| Technology makes my study activities more personal and my own | .842 | |
| The use of technology increases my motivation to study | .838 | |
| Technology is fascinating | .810 | |
| I learn more rapidly when I use technology | .806 | |
| Technology allows me to learn wherever I need to | .776 | |
| I am tired of using technology | .732 | |
| It takes longer to learn to use technology than to do the job manually | .694 | |
| Technology allows students to learn at their own pace | .648 | |
| Technology stops me from being bored | .635 | |
| Technology makes me uncomfortable | .584 | |
| Most things that one can do with technology can be done through other means | .581 | |
| When I use computers, I feel in control | .559 | |
| I don't want to know more about technology | .536 | |
| I like using technology | .532 | |
| Technology can help me organise my studies | .532 | |
| Technology makes me feel stupid | .511 | |
| I would like to know more about technology generally | .466 | |
| I feel I need more training to use technology properly | | .869 |
| I feel comfortable using technology | | .790 |
| Technology makes me nervous | | .765 |
| I need an experienced person nearby when I use technology | | .730 |
| I am comfortable using technology I have chosen in my home | | .705 |
| I am good at using technology | | .662 |
| I am easily able to learn new technology skills | | .622 |
| I generally feel confident working with technology | | .619 |
| Using technology in my home makes me anxious, even if I have chosen it | | .594 |
| I only use technology when told to | | .588 |
| I find it easy to get technology to do what I want it to do | | .520 |
| I am most confident with the forms of technology I am most familiar with | | .476 |
| I find technology confusing | | .441 |

**Table 3.4.6**
*Pilot: Rotated component structure matrix from PCA with direct oblimin rotation and Kaiser normalisation*

| | Component 1 | Component 2 |
|---|---|---|
| I am tired of using technology | .844 | .583 |
| Technology is fascinating | .835 | |
| Technology makes my study activities more personal and my own | .828 | |
| I learn more rapidly when I use technology | .819 | |
| Technology allows me to learn wherever I need to | .800 | |
| The use of technology makes a course more interesting | .777 | |
| Technology stops me from being bored | .723 | .479 |
| The use of technology increases my motivation to study | .716 | |
| Technology allows students to learn at their own pace | .714 | .413 |
| Most things that one can do with technology can be done through other means | .675 | .480 |
| Technology makes me uncomfortable | .660 | .425 |
| It takes longer to learn to use technology than to do the job manually | .659 | |
| I like using technology | .612 | .418 |
| When I use computers, I feel in control | .606 | |
| I don't want to know more about technology | .559 | |
| Technology can help me organise my studies | .556 | |
| I would like to know more about technology generally | .531 | |
| Technology makes me feel stupid | .508 | |
| I believe that it is very important for me to learn how to use technology | .492 | |
| Technology makes me nervous | .426 | .823 |
| I feel comfortable using technology | | .815 |
| I feel I need more training to use technology properly | | .787 |
| I am comfortable using technology I have chosen in my home | | .732 |
| I am good at using technology | .411 | .726 |
| I generally feel confident working with technology | .516 | .721 |
| I am easily able to learn new technology skills | .505 | .720 |
| Using technology in my home makes me anxious, even if I have chosen it | | .659 |
| I need an experienced person nearby when I use technology | | .654 |
| I am most confident with the forms of technology I am most familiar with | .445 | .570 |
| I find it easy to get technology to do what I want it to do | | .569 |
| I find technology confusing | .467 | .546 |

**Table 3.4.7**
*Pilot: Component correlation matrix from PCA with direct oblimin rotation and Kaiser normalisation*

| Component | 1 | 2 |
|---|---|---|
| 1 | 1.000 | .321 |
| 2 | .321 | 1.000 |

## 3.5 Interview Design

The goal of the interview was to invite students to expand upon some of their answers to the questionnaire, and to begin to create an understanding of the factors behind their attitudes and use of TEL and technology. The interviews would allow me to generate insight into further differences in attitudes between students of different ages, thus contributing to research question one. In an interview, we would also have time to discuss why students had these attitudes, and think about factors underlying them, which contributes to research question two. Conversations about technology perhaps inevitably lead to discussions about the design of technology, so I hope to be able to use the interview as well to think about design implications for research question three.

For each interview, I followed a semi-structured interview protocol, which consisted of reminders of the questions I wanted to ask, including prompts for depth solicitation, such as "why". This was because I wanted to ensure I was generating the same broad areas of conversation from each of my participants; however, I also wanted to allow space for the conversation to develop flexibly outside of my set of questions, allowing each interview to be more personal (Turner III, 2010). My interview protocol was divided into six sections, with the expectation that if the conversation went a certain direction, I would be able to reorder the questions in a way that made sense for the interview.

I chose to open each interview with an attempt to establish rapport with my interviewee. I did this by planning to introduce myself, and ask them how they are. I expected that this conversation would be different for students I knew and those I didn't. I also planned to offer refreshments and biscuits to encourage a less formal atmosphere. Following this, I aimed to let the participant know the purpose, timeline, and structure of the interview. This also acted as an explicit reminder to me to arrange handover of the information sheet, to sign the consent forms, and to begin audio recording, assuming the participant had agreed to this. Although not explicitly stated in the protocol, in setting up the audio recorder, I tested it by asking participants what they had had for breakfast that morning. I then played back the recording so we both could hear it. As well as checking the dictaphone was working, this was a fun icebreaker for the conversation.

The rest of the interview uses a funnel approach (Oppenheim, 1998), starting with concepts and narrowing down into specifics. The second section of the interview starts the conversation around what participants understand by the term "technology-enhanced learning". This allows me to understand how participants define technology and TEL in their answers, and also to be able to change the way I refer to technology to match their explanation, or to define TEL or TLEs for them if they do not know.

In addition to original questions, I took some of the unused questionnaire items from an initial draft that I felt would be worth exploring in more detail in an interview situation. There were several topic similarities in the unused items, and once I had generalised these to more open interview questions, they seemed appropriate to expand upon the attitude items included in the TAQ.

Following the TEL concept discussion, the third set of questions in the interview were about participants' enjoyment of technology, both for learning and for personal use. This was inspired by questions on enjoyment from instruments by Edmunds et al. (2012), Nguyen et al. (2006), Sagin Simsek (2008), and Porter and Donthu (2006), among others, since enjoyment is a common factor affecting technology attitude and adoption. I chose to ask about both technology for learning and technology generally as there may be differences in how students feel about the use of technology in course and non-course activities, and I had already included questions about the different technologies used for each in the questionnaire. This was therefore an opportunity for students to expand on their enjoyment (or hatred) of the technologies that they had used. I explicitly included questions about their least enjoyable technologies as well as their most enjoyable, to try and elicit responses about technologies they might not have thought to tell me about (Gemignani (2014, p. 131) calls this "the untold"), constructing a more complex and richer story, and encouraging participants to reflect on and evaluate their experiences (Gemignani, 2014).

The fourth section of the interview includes questions about students' confidence with technology (Garland & Noyes, 2005; J. J. Lee & Clarke, 2015), the forms of technology they are most and least confident with (Jay & Willis, 1992; Pierce et al., 2007; Teo, 2008), their confidence about learning about technology (Edmunds et al., 2012; J. J. Lee & Clarke, 2015; Porter & Donthu, 2006), whether they need support (Bonanno & Kommers, 2008; Teo, 2008), and whether they are anxious about technology and when (Jay & Willis, 1992; Saadé & Kira, 2007; Teo, 2008). Confidence, like enjoyment, has been found to be a common factor that affects students' attitudes. I initially wanted to ask students to rate their confidence level on a scale of one to ten, to open the conversation about confidence. This also provides a way to compare students of different ages. I hoped that by asking them to link their confidence self-evaluation to specific forms of technology, I might generate some depth of reflection on why they felt the way they did, and again to evaluate their experiences. Asking whether they are most anxious using technology before, during, or after using it was also designed to get students to think about when and therefore why they experienced technology anxiety (Czaja & Sharit, 1998).

Asking about whether the participants felt they needed support, whether they actually seek it, and from whom or what, was intended to encourage them to think about the relationship between their perceived confidence level and how they sought support. I was particularly interested in this since many students in my experience view seeking support as a weakness, whereas recent research has shown that it is both a self-regulated learning strategy and a social interaction strategy (Karabenick, 2011; Puustinen & Rouet, 2009).

The penultimate section of the interview asks students about their knowledge of technology. I wanted to begin with asking my participants if they had any ICT, computing, or other technology qualifications, what they were, and when they got them. This was primarily to see if there were any differences in attitudes between those with formal qualifications in technology and those without, as well as to gauge their level of experience in formal settings (Liaw et al., 2007). This question is followed by opening up the conversation again by asking students what they understand by the term "technology knowledge". This was interesting to me, since Bloom's Revised Taxonomy explicitly contains a separate knowledge dimension consisting of different stages of knowledge, in addition to the cognitive process dimension (Anderson et al., 2001). I then wanted to ask students whether they felt knowledgeable about technology, as this could elicit further conversation about the nature of technology knowledge. Knowledge is also something that was mentioned in the previous instruments I surveyed, although in those instruments, the questions tended to be more about desire for knowledge (Jay & Willis, 1992; J. J. Lee & Clarke, 2015).

Since my first two research questions are about differences in attitudes between students of different ages, I wanted to ask students how knowledgeable they felt about technology compared to people who were younger, older, and the same age. I was interested in whether they held any stereotypical views, or why they felt some age groups were more or less knowledgeable. I also asked them about how knowledgeable they felt compared to friends and family, as I thought this might include specific examples, whereas just 'younger' or 'older' can be thought about more abstractly.

My last question about knowledge was asking them which technologies they used before coming to university, and which the university introduced to them. This was following up on the questionnaire question about which technologies they used for course and non-course activities. Although this question was not based on one I found in the literature, I hoped it would generate some insight on compulsory vs non-compulsory technology use.

Finally, my last section was a closing section. I opened up the conversation again by asking students whether there was anything else they thought it would be helpful for me to know or that they wanted to add. This was to allow them to say anything they thought they had been unable to say in the rest of the interview, and to allow me as a researcher to understand if there were any common areas my interviews had been lacking. After this question, I planned to close the interview while maintaining rapport, thanking each participant for their time. I also planned to ask whether they wanted to be entered into the draw for an Amazon voucher for their interview, which I again wanted to be optional as with the questionnaire. I also wanted to check whether participants would be happy for me to contact them if I had any questions, as this would allow me to clarify anything with them if I later found it to be unclear. I did not anticipate using this option, but I felt it was important to check with the students. Lastly, I ended on another thank you.

### 3.5.1 Interview Pilot

The first draft of the interview schedule was reviewed by my supervisors for clarity, and following this, some changes were made to the question phrasing. I initially pre-piloted the draft questionnaire on a volunteer family member, where I asked about question clarity and understanding of what they had to do. I paid attention to the ease of asking each question in person, and to get a rough idea of how long it would take per interview.

Following administration of the pilot questionnaire, I then wanted to invite volunteer participants to a pilot for the follow-up interview (the interview protocol can be found in Appendix E). This would provide me with more feedback on question clarity and ease of asking in an interview situation with a stranger, and also would allow me to pilot my method of inviting and arranging interviewees.

In the pilot questionnaire, participants were invited to provide their email address should they be interested in participating in follow-up interviews about the topic of technology-enhanced learning. After the questionnaire closed, I organised the interview volunteers' emails into age groups, and used purposive sampling to choose several participants from each age group to invite to be interviewed. The invitation email invited interviewees to sign up for a Google Calendar appointment slot at a time and date that suits them. I suggested that each interview would take approximately 30 minutes based on the pre-pilot interview length, however I allotted each interview a one-hour slot in case the participant wished to extend the interview, or it ran over. A copy of the participant information sheet was included with the email to allow participants to make an informed decision about whether they wished to participate. After each interviewee booked their slot, I sent a confirmation email thanking them for signing up, confirming the time and date chosen, and providing directions to the interview location.

After a first round of invitations were sent out, I checked how many participants from each age group had signed up, and I sent out further invitations to try and get a wider range of ages. I also sent out emails to the original volunteers, reminding them to sign up if they wanted to participate. Overall there were three rounds of invitations to interview issued.

Interviews were held in private rooms in my office at the university. Each interview was recorded with a digital dictaphone to maintain high fidelity. I chose not to make notes in addition to the recording, and instead to focus on the conversation. At the beginning of each interview, I explained the purpose of the study, and asked the participant to read the participant information sheet before signing the consent form. Although the consent form asked participants to initial each point, many participants ticked them, which I accepted in order to allow the interview to flow more naturally. I tested the dictaphone by asking each participant what they had for breakfast, and listening back with the participant to ensure the recording was loud and clear enough. I then began the recording for the full interview and did not stop the dictaphone at any point until the interview was complete.

Following the pilot interview, I asked participants about question clarity, whether they objected to answering any of the questions, whether any major topic was omitted, and whether the flow of the interview made sense. I also asked if they had any further comments, and made a note of how long each interview took in order to give participants a more accurate estimate when inviting them for the full-scale study. Several changes were made as the result of this pilot, including reordering some of the questions, and rewording others. I also included prompts and probes explicitly in my interview schedule, to be used if my participants were having trouble thinking of answers.

**Table 3.5.1**
*Main Study: Interview invitations and acceptances per round, and overall response rates*

| Age group | Number of volunteers from survey | Percentage of survey participants who volunteered | Round one | | Round two | | Round three | | Overall response rate |
|---|---|---|---|---|---|---|---|---|---|
| | | | Invited | Interviewed | Invited | Interviewed | Invited | Interviewed | |
| <18 | 0 | 100% | | | | | | | |
| 18-21 | 22 | 31.0% | 3 | 1 | 3 | 0 | 16 | 2 | 13.6% |
| 22-25 | 15 | 36.6% | 4 | 1 | 2 | 0 | 9 | 1 | 13.3% |
| 26-30 | 3 | 16.7% | 3 | 1 | | | | | 33.3% |
| 31-40 | 5 | 29.4% | 4 | 0 | 1 | 0 | | | 0.00% |
| 41-50 | 4 | 50.0% | 4 | 4 | | | | | 100% |
| 51-60 | 0 | 0.00% | | | | | | | |
| 61-70 | 1 | 100% | 1 | 1 | | | | | 100% |
| 71+ | 0 | 100% | | | | | | | |
| Total | 50 | 31.1% | 19 | 8 | 6 | 0 | 25 | 3 | 22.0% |

*Note.* Blank cells indicate no invitations or responses were issued (usually due to lack of potential participants, for example if all volunteers had already been contacted, or no one volunteered)

I made one further change as a result of the pilot in the administration of the interview. As one of my pilot interviewees did not show up, I decided to send reminder emails to volunteers one day before their respective interviews. This seemed to work, as 100% of my volunteers for the full-scale study attended the interviews. Table 3.5.1 shows how many participants volunteered, were invited, and were interviewed at each stage of the main study process, as well as the overall response rate. The main study interviews ranged from approximately 22 to 56 minutes in duration, and I did not curtail the natural length of the interview at any point.

## 3.6 Trustworthiness

Since the constructs of credibility, transferability, dependability and confirmability are linked, many of the steps I took to improve one impacted on the others. Although I anticipated that this would be in a positive way, I maintained vigilance throughout the study in case this was not the case.

I attempted to maximise credibility by using triangulation and mixed methods, generating data in multiple ways in order to more fully explore participants' views and experiences. This also takes advantage of the benefits of different methods while others compensate for their limitations. All interactions with my participants were audio recorded so that I could play them multiple times in order to become more familiar with them. I tried to maximise the number of participants so that I could include a variety of different people in my study. This enabled me to develop a richer picture of my participants, and also made it easier for me to see similarities and differences between them. I attempted to build trust by spending sufficient time with my participants, and maintaining communication through the study process. Participants were given frequent and clear opportunities to withdraw from the study without having to give a reason, so that no data generation was carried out under duress. I judged that this would lead to engaged respondents who were therefore more likely to answer questions honestly and fully. Throughout the study I did member checking by asking for immediate clarifications during interviews, or summarising a participants' point to ensure that we were reaching a shared understanding. I also invited colleagues and my supervisors to scrutinise my work and offer feedback throughout; this provided a fresh viewpoint on some matters, and also assisted me to challenge my own experiences and assumptions that may have otherwise been overlooked to my closeness to the project.

To identify transferability opportunities, I provide rich description throughout the study, and provide detailed contextual details. I believe this study will be quite transferable, as I have no reason to believe the mature students of my HE institution are very different from those of other UK universities; my experiences of the mature students I teach and otherwise encounter are congruent with the literature. I therefore suggest that although my participants are of course unique in space and time, they are an appropriate sample of a larger population (Stake, 2011).

I attempted to maintain dependability by recording thorough process notes and writing a research diary. The data generated from this study was recorded and coded in a transparent and systematic manner so that other researchers will be able to easily comprehend the themes of my data, and understand my reasoning behind dealing with the data. In this way, they should be able to arrive at broadly similar conclusions about my data, although they will be viewing my data through their own cognitive lenses.

In order to maximise confirmability, I used multiple methods and triangulation to attempt to generate a more trustworthy representation of the participants' views. I therefore chose to perform interviews after the questionnaire, in order to allow participants the opportunities to clarify their questionnaire answers and ensure that their views are represented accurately. The questionnaire was also designed such that there were multiple questions probing the same set of behaviours or mindsets. I have included a detailed narrative of my positionality and potential biases, and will signpost these explicitly as they arise, in order to rationalise my decisions throughout the study and maintain reflexivity in my audit trail.

## 3.7 Ethical Considerations

Throughout the study, I conformed to the ethical processes put in place by the HE institution within which I teach. The study was approved by the ethics committee within that institution. The ethics application for the research is attached as Appendix B.

Informed consent was sought. To this end, all participants were given full details of how their data would be generated and used. Prior to participating, all participants were given an information sheet (see Appendix C) detailing the purpose and nature of the study. Further details were provided regarding the potential benefits from the research, and how any results will be disseminated. I was vigilant in considering that providing this information might bias the results (L. Cohen et al., 2011), however I do not believe this affected the questionnaire or interviews.

Participation in the study was voluntary, and participants were allowed to withdraw from the study at any time without providing a reason, and this was made clear to them from the start. The opportunity to re-join was also available. I was concerned that some element of a power differential may have arisen due to my status as a staff member of the University (L. Cohen et al., 2011); the department in which I teach is a specialist department for mature students, so there may be perceived pressure on students of my department to respond to my requests for participation. I attempted to prevent this by contacting potential participants through the regular university channels, which involved sending a mass email to the student volunteers mailing list. I also minimised the prominence of my name and details in the invitation email to increase the chance that my students will make their decision on whether to participate or not before encountering my name.

Participants were asked to fill in and sign a consent form (see Appendix D), as well as being able to ask any questions at any point. Explicit consent was sought to be able to use participants' anonymised transcripts from interviews. For the online questionnaire, I provided my e-mail address so that students completing the online portion of the study could contact me prior to commencement. During the face-to-face interviews, I verbally checked that participants fully understood the information provided before signing a paper-based consent form in addition to that signed online, as suggested by Cohen et al. (2011).

All data has been kept confidential within the scope proposed to participants and stored securely on a password-protected laptop and within a folder in a password-protected Google Drive folder. Absolute confidentiality of the data cannot and should not be promised as the data will be used within this study, and potentially in journal publications (L. Cohen et al., 2011; P. Oliver, 2010). For the questionnaire, respondents are identified only by a unique identifier number. Names and contact details provided for interview or prize draw reasons are kept in a separate document which stores the unique identifier numbers and the participants' details. This has been kept completely separate from the data generated for the study, so that it is impossible to obtain names and contact details from the study data. Pseudonyms have been used to maintain anonymity. No information has been disclosed that will allow participants to be identified or otherwise traced, which means that references to the institution, location-specific services, and people they mention have also been anonymised. Data protection laws and university policy were followed, so that participants can view their stored data at any time.

Some of the issues regarding demographic identification, and personal experiences with technology and university may be upsetting to students, and therefore were dealt with sensitively; contact details for the University Counselling Service was pre-emptively provided should students have felt that they needed any further support. The pilot study was used, not only to assess the instruments, but also to monitor the effect of the study itself on the participants in order to identify any problematic or upsetting elements. There was, in fact, a specific question asking if students objected to answering any of the questions I asked. Problematic elements can be signposted to participants in advance of participation, so they can make a more informed decision about whether to participate. However, in practice, neither the pilot study nor the full-scale study suggested any difficult elements for students.

Oliver (2010) suggests that inducements to participate may be offered to encourage questionnaire responses, however this may change the relationship between researcher and participant. Although it is important to build rapport with my participants, I don't feel that monetary recompense would affect this relationship, and it is likely to encourage more responses. As Oliver (2010) goes on to say, the expectation of some compensation for one's time and effort to participate in a study is very reasonable. There is a danger in that the respondents and participants are only doing it for the reward, and therefore their engagement is perfunctory, or even skewed towards what they think the researcher wants to hear (L. Cohen et al., 2011).

In my study, I chose to offer, instead of a reward to each participant, a prize draw for all questionnaire respondents. Each student who completed my questionnaire was entered into a prize draw for one of two £10 Amazon vouchers. This voucher value was chosen as the questionnaire was estimated to take no longer than 30 minutes, and the £10 reward seemed a large enough amount to be an incentive, but not too much for the amount of time and effort invested by the participant. Participants were asked for their email address in order to be entered into this draw, but these details were only used for the draw, and not kept for any part of the study otherwise. This was made clear to the students. There was a separate prize draw for those students who volunteered for the follow-up interviews. Again, all participants who so desired were entered into a draw for a £10 Amazon voucher, which was not mutually exclusive from the questionnaire prizes. Overall, three Amazon vouchers were sent out to participants using the Amazon email gift card service, and confirmations of receipt were received.

## 3.8 Data Analysis

This section explains and justifies the analysis done for each stage of the study in order to identify differences between the age groups.

### 3.8.1 Quantitative Analysis: Questionnaire

The goal of the questionnaire analysis was to determine whether there was any difference in usage and attitudes to technology-enhanced learning and technology between the different age groups. To assess this, I analysed the data based on two different comparisons. The first asks whether there is a difference in the results between the two broad categories of student, mature (26+) and non-mature (under 26). The secondary comparison considers differences across the larger number of age groups. In addition to the attitudinal Likert-style data which was ordinal, I compared how students used technology. The data for frequency of use and length of time of use is also ordinal, whereas the data for number of different technologies used (for course, non-course, and both) is scale data. This affects the tests I will carry out to compare the age groups.

#### *3.8.1.1 Exploratory Factor Analysis*

In order to analyse the attitudinal data from the questionnaire, I used an exploratory factor analysis (EFA) to determine the factor structure of the TAQ. EFA is a data-driven method to identify the number of latent factors and which items load onto them. The data for each attitude factor, as well for overall attitude, can then be used in significance testing to determine the differences between ages.

There has been some discussion in the literature about what constitutes a sufficient sample size for an EFA (MacCallum et al., 1999; Matsunaga, 2010). Gorsuch (1983) recommends at least 100 participants in the sample, whereas Comrey and Lee (2013) say that this size of sample is “poor”. Everitt (1975) and Child (2006) recommend ten participants for every item. However, MacCullum et al. (1999) suggest there are a number of factors affecting the ideal sample size. When the factor analysis has high communalities of more than 0.6, the impact of sample size is greatly reduced. With communalities in the region of 0.5, the factors must also be well-determined, which means having several items load onto them, and a sample of 100-200 is ideal. If the communalities are low, but there are a small number of factors that are highly over-determined to the extent of six or seven items per factor, then a moderate sample size of anywhere over 100 is sufficient. Matsunaga (2010) simply suggests that if factor analysis is used, researchers should make their sample size as large as possible. For the purposes of this study, the Kaiser-Meyer-Olkin measure of sampling adequacy was used (Parsian & Dunning, 2009).

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity both assess the suitability of the data for factor analysis, shown in Table 3.8.1. Data which gives rise to a KMO index greater than 0.5 are considered suitable (Williams et al., 2010), with KMO indices greater than 0.8 being "meritorious" or "good", and those greater than 0.9 being "marvelous" or "superb" (Kaiser, 1974; J.-O. Kim & Mueller, 1978; Parsian & Dunning, 2009). Significant results for Bartlett's test of sphericity also indicate suitability for factor analysis (Williams et al., 2010), but this is sensitive to sample size (Tabachnick & Fidell, 2007). With a KMO index of 0.910 and a highly significant result ($p < 0.001$) for Bartlett's test, my data is deemed suitable for factor analysis.

**Table 3.8.1**
*Main study: KMO and Bartlett's Test to determine suitability of data for EFA*

| Kaiser-Meyer-Olkin measure of sampling adequacy | | .910 |
|---|---|---|
| Bartlett's test of sphericity | Approximate chi-square | 3366.705 |
| | Degrees of freedom | 465 |
| | Significance | .000 *** |

*Note*. *** denotes significance at the $p < 0.001$ probability level

### *3.8.1.2 Significance Testing*

For each set of data for which I wanted to test (number of different technologies used, frequency of use, length of time of use, and attitudes), I first assessed the normality of each distribution. Normality tests in general are of dubious quality, since small samples often spuriously pass normality tests, but large samples often spuriously get rejected (Ghasemi & Zahediasl, 2012). Instead, it is recommended to inspect the Q-Q plots and distributions when assessing whether data meets the assumption of normality (Ghasemi & Zahediasl, 2012). For SPSS, there are two options for normality tests: Shapiro-Wilk or Kolmogorov-Smirov. The Kolmogorov-Smirov test is considered to have much lower power compared to the Shapiro-Wilk test (Ghasemi & Zahediasl, 2012). I have therefore used Shapiro-Wilk tests to assess normality, but since the Shapiro-Wilk test often rejects the null hypothesis of normality too easily, I also visually inspected the Q-Q plots and histograms (Ghasemi & Zahediasl, 2012; Pleil, 2016).

Where the distributions were found to be normal, I used t-tests to assess differences between mature and non-mature students, and I used one-way analyses of variance (ANOVAs) to explore whether there were differences between the smaller age groups. I used Levene's test to assess homogeneity of variances across groups, and where they were found to be different, I used Welch's ANOVA. Where the groups were found to be non-normal, I used the non-parametric tests of the Mann-Whitney U test to compare mature and non-mature students, and the Kruskal-Wallis H test for the smaller age groups.

#### *3.8.1.3 Assumptions*

Each type of test has a number of assumptions. These need to be carefully explored before the test is conducted, as breaking these assumptions may reduce or completely eliminate the credibility of the test (Ghasemi & Zahediasl, 2012).

EFA has five main assumptions: there are multiple scale variables; there is a linear relationship between all variables; there is sampling adequacy; the data are suitable for data reduction; and there are no significant outliers. Although EFA assumes scale data, it is common to use ordinal data such as Likert-style scales, and there is little difference in results between ordinal and scale data (Cho et al., 2009). Similarly, the use of Pearson's coefficients assumes linear relationships and sometimes a polychoric coefficient is preferred, although again, there is often little difference in result (Cho et al., 2009). Sampling adequacy and suitability for data reduction have already been affirmed through KMO and Bartlett's test respectively. The standard deviations of the components was checked for outliers, and none were found.

Parametric t-tests and ANOVAs have four main assumptions: the data should be from a normally-distributed population; the variances should be fairly homogeneous; the dependent variable should be scale data; and there should be independence of observations. However, t-tests are fairly robust to some of these assumptions. They are robust to violations of the normality assumption, as long as the sample sizes are approximately equal and fairly large, usually more than approximately 25-30 cases (Sawilowsky & Blair, 1992). Although in several cases my data does not fulfil the assumption of normality, Sawilowsky and Blair (1992) found that using a t-test on non-normal data results in a conservative result, i.e., the test is less likely to find a significant result. This means that there is no harm done in running a t-test, even if it is not the optimal test. However, where my data does violate the normality assumption, in addition to running a t-test, I have also run a non-parametric Mann-Whitney U test (A. Hart, 2001).

Like the t-test, ANOVA is also robust to some of these assumptions, such as the normality assumption (Blanca et al., 2017), and other assumption failures can be corrected for (A. Field, 2005). However, I still chose to run Shapiro-Wilk tests and inspect the Q-Q plots as with the t-tests to assess normality. However, it is usually best that normality tests have approximately equal sample sizes, so the normality tests of my different age brackets were particularly dubious, since the sample sizes were very unequal and also small. Kruskal-Wallis tests were run in addition to ANOVA as a non-parametric alternative. Lunney (1970) found that ANOVA still works with dichotomous data, so the assumption of scale data can be relaxed, although it will not need to be in the case of my data. It is fairly easy to correct for heterogeneity of variance. For t-tests, SPSS automatically gives two sets of results, for “equal variances assumed” and “equal variances not assumed”, where it uses the Welch-Satterthwaite method to correct for unequal variances. For ANOVA, SPSS offers the Brown-Forsyth F (M. B. Brown & Forsythe, 1974) and Welch F (Welch, 1951) tests that do not assume variance homogeneity. The Welch F test was chosen as it usually performs better (Lærd Statistics, 2018). Games-Howell should be used as a post-hoc test in these cases. I used Levene’s Test of Equality of Variances in order to test whether the variances are equal for the groups for which I was considering using t-tests and ANOVAs. Finally, for both t-tests and ANOVA, independence of observations is the most important assumption – breaking it can result in an inflated type I error rate (Scariano & Davenport, 1987). Independence of observations means that each participant is only counted once (Wiedermann & von Eye, 2013), and my data fulfils this assumption.

The Mann-Whitney U and Kruskal-Wallis H non-parametric tests also have two assumptions: data is ordinal or scale; and independence of observations. Mann-Whitney tests also require that there is one independent variable which is dichotomous (i.e. the mature vs non-mature variable), whereas Kruskal-Wallis tests require two or more nominal independent variables (i.e. the smaller age groups). Additionally, the interpretation of the results of these tests depends on whether the distributions of the dichotomous variable are different or the same. When they are the same, the tests can be used to compare medians, but when they are different, the tests can only be used to compare mean ranks. Due to unequal groups sizes throughout, the mean rank (rather than sum of ranks) was used to compare groups’ differences.

#### *3.8.1.4 Effect Sizes*

Effect sizes are reported where appropriate. Kotrlik and Atherton (2011, p. 132) define effect size as the magnitude of a treatment, allowing research to judge the “practical significance” of research findings. It is important to include effect size in studies, since whether the result of a statistical test is significant does not tell the researcher anything about the magnitude of the effect. This is a common misunderstanding amongst researchers: a more significant result (i.e., a lower *p*-value) does not indicate a stronger effect (Kotrlik & Atherton, 2011). Therefore very small differences in samples may show significant results, especially when the sample is large (J. Cohen, 1994). Effect sizes also allow comparisons of results between studies (Kotrlik & Atherton, 2011).

Effect size calculations, like most analyses, are sensitive to assumptions, especially violations of normality and homogeneity of variance (Leech & Onwuegbuzie, 2002). Small sample sizes also affect some effect size calculations. Table 3.8.2 shows suggested effect size calculations for the various types of analysis.

**Table 3.8.2**

*Recommended effect size measures for the statistical tests used in this report*

| Statistical test | Effect size measure |
|---|---|
| Independent t-test | Cohen's *d*, **Hedges' *g***, Glass's Δ |
| ANOVA | $\boldsymbol{\eta^2}$, $\omega^2$, Cohen's *f* |
| Mann-Whitney U test | $\boldsymbol{r}$, $r^2$, $\eta^2$ |
| Kruskal-Wallis H test | $\boldsymbol{\eta^2}$, $E^2$ |
| Chi square | **ϕ coefficient (2x2)**, Cramer's *V* (larger than 2x2) |

*Note.* Bold denotes effect size measure I will be using. Source: Fritz, Morris, & Richler, 2012; Kotrlik & Atherton, 2011; Tomczak & Tomczak, 2014

**Table 3.8.3**

*Equations for calculating the effect sizes for each type of statistical test*

| Statistical test | Equation | Definitions |
|---|---|---|
| Independent t-test | $g = \dfrac{\bar{x}_1 - \bar{x}_2}{\sqrt{\dfrac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}}$ | $\bar{x}_{1,2}$ sample means<br>$n_{1,2}$ number of cases in groups<br>$s_{1,2}$ standard deviations |
| ANOVA | $\eta^2 = \dfrac{SS_{ef}}{SS_t}$ | $SS_{ef}$ sum of squares for effect<br>$SS_t$ total sum of squares |
| Mann-Whitney U test | $r = \dfrac{z}{\sqrt{n}}$ | $z$ standardised U-value<br>$n$ total number of cases |
| Kruskal-Wallis H test | $\eta_H^2 = \dfrac{H - k + 1}{n - k}$ | $H$ Kruskal-Wallis H statistic<br>$k$ number of groups<br>$n$ total number of cases |
| Chi square | $\phi = \sqrt{\dfrac{\chi^2}{n}}$ | $\chi^2$ chi-square statistic<br>$n$ total number of cases |

*Note.* Source: Fritz et al., 2012; Kotrlik & Atherton, 2011; Tomczak & Tomczak, 2014

Since SPSS does not calculate effect sizes automatically, I did this manually. The equations used are shown in Table 3.8.3. For the independent t-test, Hedge's *g* was used rather than Cohen's *d* because we do not know the population standard deviation that *d* requires. *g* uses a weighted pooled standard deviation instead (Tomczak & Tomczak, 2014).

Table 3.8.4 shows the small, medium, and large thresholds for the various effect sizes from Table 3.8.3.

**Table 3.8.4**
*Thresholds for effect sizes*

| Effect size measure | Small | Medium | Large |
|---|---|---|---|
| $g$ | 0.20 | 0.50 | 0.80 |
| $\eta^2$ | 0.04 | 0.25 | 0.64 |
| $\eta^2_H$ | 0.01 | 0.06 | 0.14 |
| $r$ | 0.20 | 0.50 | 0.80 |
| $\phi$ | 0.20 | 0.50 | 0.80 |

*Note.* Source: Ferguson, 2009; Morse, 1999; Tomczak & Tomczak, 2014

### 3.8.2 Qualitative Analysis

This study includes two parts of qualitative data generation and analysis: the open-ended questions from the questionnaire, and the follow-up interviews. Both of these parts, questionnaire and interview, used the same analysis method, thematic analysis. I will explain the thematic analysis method first, and then explain how I applied it to the interviews and questionnaire open-text comments. The two analyses were conducted approximately at the same time.

#### *3.8.2.1 Thematic Analysis*

I chose to do a thematic analysis in order to maintain a rich and complex view of the data, as well as due to its flexible approach (V. Clarke & Braun, 2017). The goal of thematic analysis is to identify themes and patterns in the data. Although the organisation and description of data is an important part of a thematic analysis, it goes beyond simply summarising the data, and encourages the interpretation of the data as well (Braun & Clarke, 2006). It is important to note that the researcher takes an active role in the identification of themes, as opposed to simply discovering emerging themes in a passive role (Braun & Clarke, 2006). In this way, although thematic analysis has no underlying methodology in particular, it is compatible with constructivism in which participants and researchers are taken to be generating data about their respective realities together (Braun & Clarke, 2006). The thematic analysis in this project has been done from a constructivist worldview.

I have used an inductive thematic analysis for this project, which is a data-driven, bottom-up approach. This is where the codes and themes have been allowed to be generated from the data without using an existing coding framework (Braun & Clarke, 2006). A semantic level of analysis was adopted, focussing on the rich details of what the participants said and interpreting and explaining any patterns in that (Maguire & Delahunt, 2017).

Thematic analysis has six steps, proposed by Braun and Clarke (2006):

1) Familiarisation – transcribing, reading the transcriptions, making notes of initial ideas;
2) Coding – generating initial codes for interesting features of the data for the whole dataset;
3) Identification of themes – collating codes and coded data into potential themes;
4) Reviewing themes – checking the themes against the coded data and the whole dataset;
5) Defining themes – refining the content of themes and assigning them names;
6) Reporting – the final analysis in selection of "vivid, compelling extract examples" (Braun & Clarke, 2006, p. 87) and putting these in context.

#### *3.8.2.2 Interview Analysis*

During the interview and subsequent transcription, I initially familiarised myself with the data as it was generated, as per step one of Braun and Clarke's thematic analysis (2006). Transcription in particular was an excellent way to become familiar with the data, as I was having to listen to the meaning of what participants were saying in order to write it down; it is important to reiterate that transcription itself is an interpretive process.

I transcribed the interviews from the audio files recorded by the dictaphone. I approached the transcription with a literal verbatim but denaturalised transcription (Halcomb & Davidson, 2006; McLellan et al., 2003; D. G. Oliver et al., 2005). All data transcription has the transcriber as a participant, in how they decide to transcribe, which conventions are chosen, particularly in the choices made in denaturalised transcription (D. G. Oliver et al., 2005). I included all pauses, laughs, stutters, filler words such as "um" or "like", and partial sentences that were never completed, but did not transcribe tone, accent, small time gaps, etc. I wanted to reduce the likelihood of omitting anything important in the process at this early stage, but make the transcript easily readable and understandable. I felt that, for this particular project, my conversations with participants were accurately reflected in their actual words, with little additional meaning given by the way in which they said something. However, where I felt something such as a longer pause or laugh was important to the participant's story, I did include it. Table 3.8.5 below shows the notations I adopted in transcription. Appendix J includes a sample of my literal verbatim transcription. I then read back through the transcriptions in tandem with listening to the recordings to check for accuracy, and adjusted any mistakes I had made in the first transcription (Braun & Clarke, 2006).

**Table 3.8.5**
*Transcription notation for the interview*

| Symbol | Definition and use |
|---|---|
| R: | Rachel (interviewer) speaking |
| P: | Participant (interviewee) speaking |
| / | Both interviewer and interviewee speaking at once |
| : | Drawn out sound, usually in the middle of a word |
| = | End of one part of speech following immediately after by another, no pause |
| - | Used when a word or phrase is cut off abruptly halfway through |
| …, | Speech trails off |
| "word" | Speech marks are where the speaker is quoting themselves or someone else |
| *word* | Italics indicate emphasis by the speaker |
| [pause] | Pause in speech |
| [laugh] | Laughter by the speaker |
| [action or verb] | Where something happened in the interview |
| [word] | Where I replaced an identifying name, place, etc. with a generic term or pseudonym |
| (word?) | Where I could not fully understand what the speaker said - the bracket contains my best guess |
| (inaudible) | Where I could not understand at all what the speaker said |

After transcribing the interviews, but before conducting the analysis, I anonymised the transcripts. I replaced the participants' names with pseudonyms. It has been recommended in more recent research to allow participants to choose their own pseudonyms, or be involved in the decision in some way (Allen & Wiles, 2016). However, I did not think of this at the time of doing the interviews. When I began to approach and transcribe my interview data, it was some time after conducting the interviews, and I knew that several of my participants had already left the university. It therefore seemed unfair to allow my participants still at the university to choose their pseudonyms while those who had left were unable to do so. I therefore decided to choose all of the pseudonyms myself to ensure fairness, although this wasn't the ideal situation.

When choosing pseudonyms, I first Googled the participants' actual names to find out which culture and time period the participants' names were likely from so that I could pick something that still reflected these qualities of my participants. I used online baby name lists to find pseudonyms that also fell under the same culture and also felt like they 'fit' the participants, while trying to be sensitive regarding this. A similar process was used for the identifying people and places mentioned. This included family members, tutors, departments with university-specific names, local areas and places. Only "composite stories", that is, not using chunks of interview that could be pieced together to identify the participants, were used (Creswell, 2012, p. 57).

After anonymisation, I tidied up the verbatim transcripts to an easily-read level of English in order to make analysis easier. I removed the filler words like "um" and stutters. I also removed connecting words that obviously did nothing for the meaning, for example "like", "sort of", etc., and partial sentences that the participant didn't sufficiently complete to have any meaning. This was heavily reliant on my understanding of what the participant was saying (Braun & Clarke, 2006). Similarly, affirmation noises such as me replying "ok" or "yeah" while the participant was talking were removed to ensure coherence of the participants' answers and improve clarity of meaning. I also removed sections where I had to explain the question, unless the explanation or need for an explanation seemed pertinent to the discussion. Sections where there were exchanges consisting of several "yeah" or "so" in a row that I felt did not add to the meaning were also removed. I did not change any of the words, unless to anonymise them, and these are shown in square brackets where I did this. I also did not rearrange sentences to improve clarity of meaning, as I did not want to lose the flavour of how each participant expressed themselves. Appendix J shows a sample of my literal verbatim transcript and its tidied version, to show a comparison.

The thematic analysis was then carried out on the cleaned transcriptions generated from the interviews. Before coding began, I re-read the transcripts in an immersive way, beginning to think about meanings in order to enable a deeper comprehension of what was being said by my participants. To code the data (as per step 2), I used NVivo (NVivo for Mac, Version 11.4.3). I systematically worked through each transcript and identified and tagged all key ideas, phrases, and points that I thought were interesting aspects of the data. Each part of the data was given my thorough and full attention. As I tagged phrases, I kept the surrounding data for context where it was required, such as if the phrase was in context of a longer conversation, or if the question asked was needed in order to understand the answer. Many of the extracts fit several different codes, and I coded them under all of the potential codes. After an initial round of coding, I went back over all the transcripts again with my full list of codes, and coded any items that I had missed the first time. This was also done periodically throughout coding, and therefore this was an iterative process.

In qualitative research, instead of sample size, the idea of saturation is often used. This is where further data generation is deemed unlikely to generate new data (Saunders et al., 2018). One way to determine the number of interviews to carry out is to analyse the data as it is generated, and to continue interviewing until saturation is achieved. It is more normal in inductive thematic analysis to view saturation as something that occurs at the analysis level, when analysis shows that no new codes or themes are being generated (Saunders et al., 2018). Saturation is a continuum rather than an endpoint, which means that we should be aiming for 'enough' rather than 'all' (Saunders et al., 2018). Early interviews produce the large majority of codes. For example, Hennink, Kaiser and Marconi (2017) found that the first nine interviews in their study produced 92% of codes (and the first interview generated more than half the codes), and therefore further interviews are affected by diminishing returns (Mason, 2010). However, Hennink et al. (2017) differentiate between code saturation and meaning saturation, with full meaning saturation occurring at a much larger number of interviews. Whether code saturation or meaning saturation is required is determined by the goal of the analysis, and also by the quality of the interviews. For the identification of broad themes, code saturation may be enough, whereas if theory development is needed, then meaning saturation is more appropriate (Hennink et al., 2017). The interviews conducted as part of my study are not being used on their own in order to fully understand the data, but to support and expand upon the quantitative findings. I have attempted to conduct rich and detailed interviews, which enable more meaning construction than more superficial interviews. Therefore, for the purposes of this qualitative part of the study, code saturation has been deemed sufficient to generate broad themes. Code saturation was found after nine interviews, with the previous five interviews only adding four additional codes.

Overall, 88 different codes were generated. Table 3.8.6 shows the codes, how many ideas or phrases were coded to it (number of references), and from how many different participants these extracts were obtained (number of sources). It is worth noting that frequencies are usually not considered important in qualitative data and instead it is the meaning that is useful (Mason, 2010). However, I hold that frequencies are important in generating meaning, as if one particular aspect is mentioned multiple times, or by multiple participants, it is likely to be more important to the participant, be a strong opinion, or at least be something that leaps to mind readily. This can help to give insights into the meanings behind what the participants are saying, and to help researchers see links between different themes.

**Table 3.8.6**

*Initial codes from interview coding, arranged by number of references*

| Code | Number of references | Number of participants who mentioned it (out of 11) |
|---|---|---|
| Positive attitude | 123 | 11 |
| Negative attitude | 96 | 11 |
| Familiarity | 67 | 10 |
| Usefulness | 55 | 10 |
| Comparison with other ages | 50 | 11 |
| Support | 42 | 11 |
| TV, streaming and video | 37 | 8 |
| Enjoy technology | 35 | 11 |
| Hardware | 33 | 8 |
| How children or younger people use tech | 33 | 11 |
| Confidence | 30 | 11 |
| Communication | 28 | 9 |
| Easy | 28 | 8 |
| Learning from others | 28 | 10 |
| Practical use | 26 | 9 |
| Access | 25 | 11 |
| Fit for purpose | 25 | 9 |
| Changes over time | 24 | 11 |

| | | |
|---|---|---|
| Desire to learn | 22 | 11 |
| Exposure | 22 | 10 |
| Job or workplace | 21 | 6 |
| How older people use tech | 20 | 11 |
| Makes life easier | 20 | 7 |
| Frustration | 19 | 6 |
| Lecturers' use | 19 | 4 |
| Programming and behind the scenes | 19 | 9 |
| Reliability or breaks | 19 | 7 |
| Social media | 19 | 8 |
| The Internet | 19 | 8 |
| Discipline or subject | 18 | 8 |
| Excel | 18 | 7 |
| Speed | 18 | 9 |
| Interest | 17 | 8 |
| Learning on own | 17 | 10 |
| Convenient | 16 | 7 |
| Necessity | 16 | 5 |
| Worry | 16 | 8 |
| Technology learning | 15 | 8 |
| Complexity | 14 | 8 |
| Formatting and layout | 14 | 6 |
| Replaces face to face | 14 | 3 |
| Understanding | 12 | 5 |
| Casual mention of non-normal technology | 11 | 4 |
| Learning style | 11 | 6 |
| Powerpoint | 11 | 8 |
| Quizzes | 11 | 3 |
| Technology knowledge definition | 11 | 11 |
| TEL definition | 11 | 11 |
| Doing the right thing | 10 | 6 |
| Interactivity | 10 | 4 |
| Saves time | 10 | 5 |
| Avoid | 9 | 6 |
| Challenging self | 9 | 6 |
| Depth of knowledge | 9 | 5 |
| Knowledge as knowing lots of tech | 9 | 7 |
| Offline | 9 | 3 |
| How you look to others | 8 | 6 |
| Intuitive | 8 | 3 |
| Novelty | 8 | 5 |
| Trust | 8 | 5 |
| Addiction | 7 | 4 |
| Distraction | 6 | 5 |
| Quality | 6 | 3 |
| Enjoyment changed | 5 | 5 |

| | | |
|---|---|---|
| Feedback | 5 | 2 |
| Group learning | 5 | 4 |
| Keeping updated | 5 | 4 |
| Not scared | 5 | 2 |
| Office suite | 5 | 3 |
| Overload | 5 | 3 |
| Standardisation | 5 | 4 |
| Too pervasive | 4 | 3 |
| Cybercrime | 3 | 3 |
| Fear | 3 | 2 |
| Flexibility | 3 | 3 |
| Fragility | 3 | 2 |
| Gadgets | 3 | 2 |
| Games | 3 | 2 |
| Gender | 3 | 3 |
| Incompatibility | 3 | 2 |
| Cost | 2 | 2 |
| Customisable | 2 | 1 |
| Exciting | 2 | 1 |
| Range of abilities | 2 | 2 |
| Tired of using tech | 2 | 2 |
| Verification | 2 | 1 |
| Disability | 1 | 1 |
| Multitasking | 1 | 1 |

The extracts and codes were then checked for consistency, as the coding had been done over the course of several months. The codes were also then checked for discrete meaning. Codes that explored the same meaning or that were redundant, were merged together (Nowell et al., 2017), resulting in a final set of 79 different codes.

Lincoln and Guba (1985) suggest getting the participants to check findings and interpretations in order to improve credibility, however this was not done as part of this study due to the long period of time over which the analysis was conducted, and most of the participants had already left the university. Since I was the only researcher to be involved in generating interview data with my participants, I felt that it would change my results if I asked another colleague to interpret my results with me, although I did get a colleague to review my themes once I had mostly finalised them.

The arrangement of codes into themes and subsequent stages of the thematic analysis is discussed as part of the Results.

### *3.8.2.3 Questionnaire Open-Text Comment Analysis*

The optional open-text comments from the questionnaire were analysed in broadly the same way as the interview transcripts. Twelve short comments were left in the open-text box, of which 11 were relevant for the thematic analysis. Most of the comments were two or three short sentences.

I first familiarised myself with the comments (as per step 1). Overall, nine codes were generated. These are shown in Table 3.8.7, along with the number of references and the number of participants who mentioned it. Since each comment was so short, these numbers are very similar.

**Table 3.8.7**

*Initial codes from open-text comment coding, arranged by number of references*

| Code | Number of references | Number of participants who mentioned it (out of 11) |
|---|---|---|
| Making tasks harder | 6 | 5 |
| Usefulness | 5 | 5 |
| Reliability | 3 | 3 |
| Distraction | 3 | 3 |
| Training/support | 3 | 3 |
| Apprehension | 2 | 2 |
| Overwhelming | 2 | 2 |
| Necessity | 1 | 1 |
| Technology constantly changing | 1 | 1 |

As with the interview analysis, arrangement of codes into themes and subsequent analysis stages are presented in the Results chapter.

# 4 Results and Analysis

This chapter explains the results and analysis for the questionnaire and interviews, including information about the sample demographics. It concludes with a summary of the key interpretations of the data, highlighting the main findings.

## 4.1 Sample Frequencies

A total of 161 participants completed the study. Tables 4.1.1 to 4.1.6 show the frequencies of the sample. 194 participants began the survey, with 161 participants completing it (83.0% completion rate).

**Table 4.1.1**
*Main study: Frequencies and percentages of mature (26+) and non-mature (under 26) students in the sample*

| | Frequency | Percent |
|---|---|---|
| Non-mature | 112 | 69.6 |
| Mature | 49 | 30.4 |
| Total | 161 | 100.0 |

**Table 4.1.2**
*Main study: Frequencies and percentages of students of the different age ranges in the sample*

| Age bracket | Frequency | Percent |
|---|---|---|
| 0-17 | 0 | 0.0 |
| 18-21 | 71 | 44.1 |
| 22-25 | 41 | 25.5 |
| 26-30 | 18 | 11.2 |
| 31-40 | 17 | 10.6 |
| 41-50 | 8 | 5.0 |
| 51-60 | 1 | 0.6 |
| 61-70 | 5 | 3.1 |
| 71+ | 0 | 0.0 |
| Total | 161 | 100.0 |

**Table 4.1.3**
*Main study: Frequencies of mode of study of mature (26+) and non-mature (under 26) students in the sample*

| | Mode of study | | |
|---|---|---|---|
| | Full time | Part time | Total |
| Non-mature | 111 | 1 | 112 |
| Mature | 32 | 17 | 49 |
| Total | 143 | 18 | 161 |

**Table 4.1.4**
*Main study: Frequencies of mode of study of students of the different age ranges in the sample*

| Age bracket | Mode of study | | |
|---|---|---|---|
| | Full time | Part time | Total |
| 0-17 | 0 | 0 | 0 |
| 18-21 | 71 | 0 | 71 |
| 22-25 | 40 | 1 | 41 |
| 26-30 | 18 | 0 | 18 |
| 31-40 | 7 | 10 | 17 |
| 41-50 | 4 | 4 | 8 |
| 51-60 | 0 | 1 | 1 |
| 61-70 | 3 | 2 | 5 |
| 71+ | 0 | 0 | 0 |
| Total | 143 | 18 | 161 |

**Table 4.1.5**
*Main study: Frequencies of course discipline of mature (26+) and non-mature (under 26) students in the sample*

| | Course discipline | | | | | |
|---|---|---|---|---|---|---|
| | The sciences | Social science | Arts and humanities | Engineering | Medicine, dentistry and health | Total |
| Non-mature | 46 | 22 | 20 | 18 | 5 | 111 |
| Mature | 7 | 23 | 10 | 6 | 1 | 47 |
| Total | 53 | 45 | 30 | 24 | 6 | 158 |

**Table 4.1.6**
*Main study: Frequencies of course discipline of students of the different age ranges in the sample*

| Age bracket | Course discipline | | | | | |
|---|---|---|---|---|---|---|
| | The sciences | Social science | Arts and humanities | Engineering | Medicine, dentistry and health | Total |
| 0-17 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18-21 | 29 | 12 | 12 | 15 | 2 | 70 |
| 22-25 | 17 | 10 | 8 | 3 | 3 | 41 |
| 26-30 | 3 | 7 | 3 | 5 | 0 | 18 |
| 31-40 | 4 | 9 | 2 | 0 | 1 | 16 |
| 41-50 | 0 | 4 | 2 | 1 | 0 | 7 |
| 51-60 | 0 | 1 | 0 | 0 | 0 | 1 |
| 61-70 | 0 | 2 | 3 | 0 | 0 | 5 |
| 71+ | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 53 | 45 | 30 | 24 | 6 | 158 |

## 4.2 Types of Technology Used

This section explores the differences in how students of different ages use the 24 different types of technology asked about by the TAQ.

Table 4.2.1 shows which age groups use which type of technology for course-only activities, non-course only activities, and for both. Figures 4.2.1, 4.2.2 and 4.2.3 show the age distributions of participants who used each type of technology for course activities, non-course activities, and both.

A variety of other technologies were mentioned in the "other" free-text box. Some of these were alternative examples that fit into the technology categories I had created (for example, Powerpoint which would be classified under "office suite", and Skype which would be classified under "video conferencing"). I checked the responses given for the pre-existing categories, and no changes had to be made as a result of these extra free-text items. Furthermore, no individual additional technology was mentioned more than once, so this data did not warrant inclusion in the analysis.

Table 4.2.1 and Figures 4.2.1, 4.2.2 and 4.2.3 present a few interesting results about the types of technologies used, and their distributions across the age groups. At this point it is worth reiterating that the sample size for the age group 51-60 was only one, so the percentage is either 0% or 100%, which may make the graphs look somewhat skewed. I will largely be ignoring this bar when commenting on the distributions.

**Table 4.2.1**

*Frequencies of use of different technologies for course activities only, non-course activities only, and both, by age range*

| Technology | Age | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 18-21 (n=71) | | | 22-25 (n=41) | | | 26-30 (n=18) | | | 31-40 (n=17) | | | 41-50 (n=8) | | | 51-60 (n=1) | | | 61-70 (n=5) | | |
| | Course | Non-course | Both | Course | Non-course | Both | Course | Non-course | Both | Course | Non-course | Both | Course | Non-course | Both | Course | Non-course | Both | Course | Non-course | Both |
| Desktop computer | 10 | 1 | 53 | 10 | 0 | 29 | 4 | 0 | 13 | 3 | 1 | 13 | 1 | 0 | 7 | 0 | 0 | 1 | 1 | 0 | 4 |
| Laptop computer | 2 | 1 | 68 | 5 | 4 | 32 | 1 | 0 | 17 | 2 | 0 | 14 | 1 | 0 | 7 | 0 | 0 | 1 | 0 | 1 | 4 |
| Tablet computer | 0 | 24 | 28 | 3 | 8 | 19 | 0 | 4 | 7 | 1 | 4 | 8 | 0 | 3 | 3 | 0 | 0 | 1 | 0 | 0 | 3 |
| Mobile telephone | 0 | 12 | 59 | 3 | 5 | 32 | 0 | 7 | 11 | 2 | 4 | 10 | 1 | 2 | 4 | 0 | 0 | 1 | 0 | 1 | 3 |
| Television | 0 | 49 | 14 | 0 | 27 | 4 | 0 | 13 | 1 | 0 | 13 | 2 | 1 | 3 | 3 | 0 | 1 | 0 | 0 | 3 | 1 |
| Radio | 0 | 46 | 7 | 0 | 24 | 3 | 0 | 13 | 1 | 0 | 11 | 1 | 0 | 5 | 1 | 0 | 1 | 0 | 0 | 3 | 2 |
| The Internet | 2 | 1 | 68 | 5 | 1 | 34 | 1 | 0 | 17 | 2 | 1 | 14 | 1 | 0 | 7 | 0 | 0 | 1 | 0 | 0 | 5 |
| MP3 player | 0 | 54 | 3 | 1 | 22 | 6 | 0 | 13 | 2 | 0 | 9 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| E-reader | 1 | 22 | 3 | 3 | 10 | 8 | 0 | 7 | 1 | 1 | 5 | 5 | 1 | 3 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Calculator | 16 | 5 | 45 | 12 | 6 | 20 | 3 | 2 | 13 | 2 | 8 | 7 | 1 | 1 | 5 | 0 | 0 | 1 | 1 | 2 | 2 |
| Email | 2 | 0 | 69 | 5 | 0 | 36 | 2 | 0 | 16 | 3 | 2 | 12 | 1 | 0 | 7 | 0 | 0 | 1 | 0 | 0 | 5 |
| Texting | 2 | 46 | 23 | 3 | 27 | 10 | 0 | 10 | 7 | 1 | 9 | 7 | 0 | 4 | 4 | 0 | 0 | 1 | 0 | 3 | 1 |
| Voting mechanism | 32 | 5 | 13 | 20 | 3 | 4 | 6 | 0 | 0 | 3 | 4 | 2 | 5 | 2 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |
| Instant messaging | 0 | 41 | 29 | 3 | 23 | 13 | 0 | 9 | 6 | 0 | 10 | 5 | 1 | 2 | 3 | 0 | 1 | 0 | 0 | 0 | 0 |
| Video calls and conferencing | 0 | 43 | 21 | 2 | 26 | 10 | 1 | 12 | 3 | 1 | 8 | 7 | 1 | 4 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| Social networking | 0 | 31 | 40 | 2 | 13 | 23 | 0 | 10 | 8 | 0 | 5 | 10 | 1 | 1 | 6 | 0 | 0 | 1 | 1 | 0 | 1 |
| Office suite | 6 | 0 | 65 | 6 | 1 | 33 | 2 | 0 | 16 | 1 | 0 | 16 | 2 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 5 |
| Videos | 1 | 16 | 54 | 3 | 11 | 27 | 0 | 4 | 14 | 1 | 5 | 11 | 1 | 2 | 5 | 0 | 1 | 0 | 0 | 2 | 1 |
| Online tutorials | 13 | 12 | 27 | 7 | 9 | 17 | 2 | 6 | 6 | 0 | 5 | 8 | 2 | 1 | 3 | 0 | 1 | 0 | 3 | 1 | 0 |
| Wiki | 3 | 9 | 59 | 5 | 3 | 30 | 1 | 3 | 14 | 1 | 8 | 7 | 1 | 1 | 6 | 0 | 0 | 0 | 1 | 2 | 2 |
| Online forums | 6 | 33 | 17 | 5 | 17 | 10 | 2 | 6 | 2 | 0 | 8 | 1 | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| VLE | 59 | 1 | 11 | 32 | 1 | 7 | 18 | 0 | 0 | 10 | 0 | 6 | 4 | 0 | 4 | 1 | 0 | 0 | 3 | 0 | 2 |
| Quizzes | 10 | 21 | 32 | 6 | 13 | 15 | 1 | 3 | 7 | 1 | 9 | 5 | 2 | 3 | 1 | 0 | 1 | 0 | 0 | 1 | 2 |
| Games | 0 | 54 | 11 | 1 | 24 | 6 | 0 | 13 | 1 | 0 | 15 | 0 | 0 | 3 | 2 | 0 | 1 | 0 | 0 | 3 | 0 |

**Figure 4.2.1**

*Bar charts showing the percentage of participants of each age group who used each type of technology for course activities*

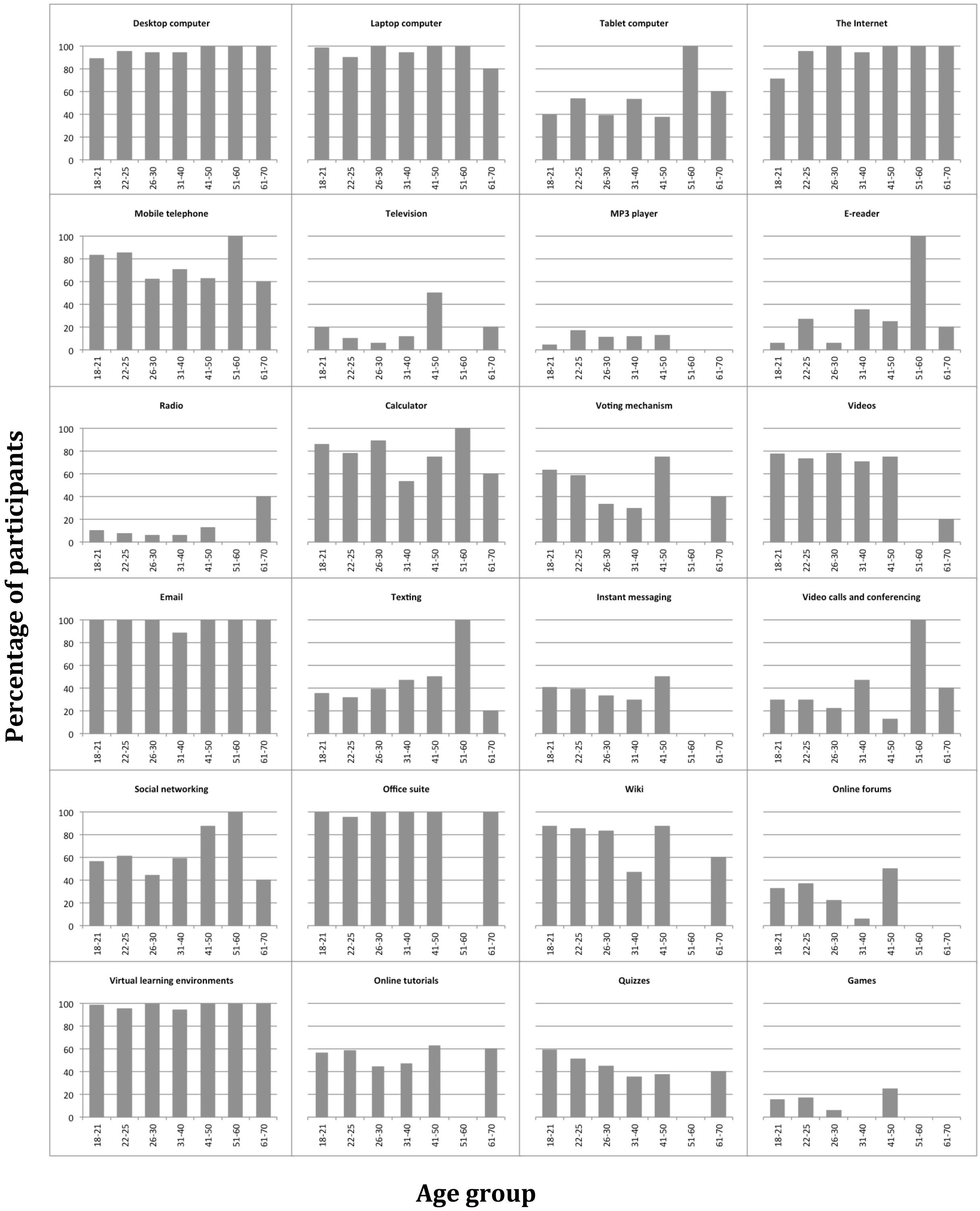


**Figure 4.2.2**

*Bar charts showing the percentage of participants of each age group who used each type of technology for non-course activities*

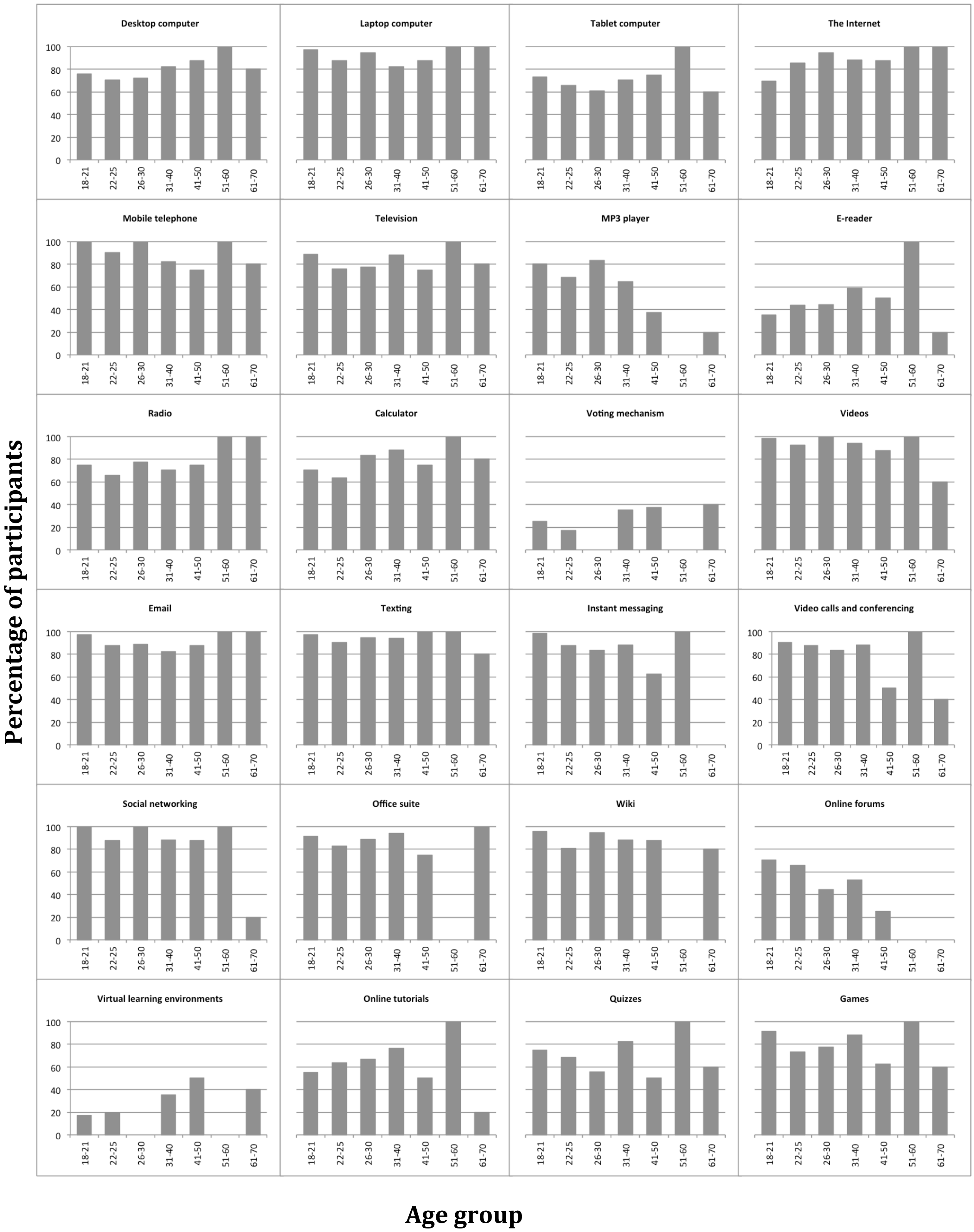


**Figure 4.2.3**
*Bar charts showing the percentage of participants of each age group who used each type of technology for both course and non-course activities*

Desktop computers are far more likely to be used only for course activities, whereas laptop computers are more likely to be used for both course and non-course activities, and tablets are more likely to be used for non-course activities only. The 41-50 age group seemed to use mobile phones for course-only activities more than other age groups, rather than a combination of course and personal use like other age groups. Ages 26-30 seemed to use mobiles mainly for non-course activities. This may be because students aged 26-30 may not have used mobiles for learning when growing up, but they did use computers; since they are comfortable with computers, they haven't felt the need to adopt mobile use. Younger students, however, may have used both computers and mobile in school learning activities, so do use mobiles for learning now. Older students probably used neither computers nor mobiles when growing up, however they seem to have adopted mobiles as part of their current general technology repertoire for learning. The 'Mobile telephone' panels in Figures 4.2.1, 4.2.2 and 4.2.3 show a trend that younger people tend to use mobiles more for both course and non-course activities, although there is still a high percentage of students who use mobiles overall.

Only one participant (who was in the age range 31-40) did not use a laptop computer for any activities, suggesting that a laptop, rather than other computing devices, was the preferred device for students in 2017. The majority of students of all ages used a laptop. Email was another technology that was heavily used – 100% of participants in the study used email. This is unsurprising as the participation invitation was extended via email, but could be argued to show that at least the participants were being relatively honest and thorough. Only one student said that they did not use an office suite, but since this student was aged 51-60 on a part-time Social Sciences course, it seems unlikely they don't use it. It is possible they did not connect the office suite programs they did use (e.g. Word) with the overarching term of "office suite", despite examples being given.

There was a surprisingly low percentage (72.2%) of students aged 18-21 who said they use the Internet. This could be due to a misunderstanding of what the Internet is, especially as 100% of them use social networking, which is all internet-based. It is interesting that there is little difference across most of the age ranges in the percentage of students who use social networking, albeit with a drop in the oldest age group of 61-70. This may be due to universities encouraging students to join Facebook groups for the course, or form their own social networks for support and study purposes.

The age group 31-40 had much higher percentages of participants who used e-readers and voting mechanisms for non-course activities only, compared to other age groups. Generally, older age groups used e-readers more often for all activities. This may be because older students prefer to read books in a hard copy format, whereas younger people may read on their computer or mobile, or perhaps read different material that is not available on e-readers which cater primarily to the traditional novel. While there was little difference across the age groups for the use of MP3 players for course activities, there is a clear trend that more younger students tended to use MP3 players for non-course activities. Perhaps as an addendum to this, older students tended to use radio more than younger students, for all types of activity. Although virtual learning environment (VLE) use was fairly ubiquitous across the age groups, for non-course activities, older students tended to use a VLE more. This could be because these older mature students do more online courses to try and catch up on their own knowledge gaps due to a less recent schooling.

Those aged 41-50 used online forums for course activities only more than any other age group, but the younger students tended to use online forums for non-course activities. Students over 41 tended to use games less for both course and non-course activities. Those in the 61-70 age bracket were the only group to not use instant messaging at all, though this could be due to the small sample size of five participants.

For most technologies, however, there was little difference in usage patterns across the age groups. There doesn't seem to be an age-based separation between technologies used for course activities and those used for non-course activities.

**Table 4.2.2**
*Descriptive statistics for the number of different technologies used by mature and non-mature students*

| | Overall | | Course activities | | Non-course activities | |
|---|---|---|---|---|---|---|
| | Non-mature | Mature | Non-mature | Mature | Non-mature | Mature |
| Mean | 21.1 | 20.0 | 13.9 | 12.8 | 18.3 | 17.4 |
| Median | 22.0 | 21.0 | 14.0 | 12.0 | 20.0 | 19.0 |
| Standard deviation | 2.8 | 3.2 | 3.1 | 3.6 | 4.4 | 4.4 |
| Variance | 7.7 | 10.2 | 9.6 | 12.6 | 19.1 | 19.6 |
| Range | 15.0 | 14.0 | 14.0 | 15.0 | 23.0 | 18.0 |

Table 4.2.2 shows descriptive statistics for the number of different technologies used by mature and non-mature students overall, by course, and by non-course activities. These differences are investigated in more detail in sections 4.2.1, 4.2.2, and 4.2.3.

### 4.2.1 Number of Different Technologies Used Overall

Different age groups of student may use different numbers of technologies. I wanted to investigate whether mature and non-mature students used significantly different numbers of technologies overall.

Levene's test of equality of variances showed that the variances for the two groups of mature and non-mature students for overall number of technologies used were the same ($F$ = 2.333, $p$ = 0.129). However, the Shapiro-Wilk test for normality showed that neither distribution was normal (Non-mature $D(112)$ = 0.855, $p$ < 0.001; Mature $D(49)$ = 0.893, $p$ < 0.001). An inspection of the Q-Q plots confirmed this. Therefore, even though the sample sizes are greater than 25, they are not equal, so the assumption of normality for a t-test is violated. Therefore a Mann-Whitney U test in addition to a t-test comparing the overall number of different technologies used for mature ($n$ = 49) and non-mature ($n$ = 112) students was carried out.

The t-test showed that mature students used fewer technologies ($M$ = 19.96, $SD$ = 3.20) than their non-mature counterparts ($M$ = 21.06, $SD$ = 2.77), which was a statistically-significant difference, $M$ = 1.10, 95% CI [0.12, 2.09], $t(159)$ = 2.217, $p$ = 0.028. The effect size ($g$ = -0.378) is small.

For the Mann-Whitney test, the distributions of the two groups were assessed by visual inspection, and found to be dissimilar. The difference in the number of different technologies used by mature (mean rank = 68.59) and non-mature (mean rank = 86.43) students was found to be statistically significant ($U$ = 2136, $z$ = -2.259, $p$ = 0.024), with mature students using fewer different technologies than non-mature students. The effect size for the Mann-Whitney test is small ($r$ = -0.178), with age accounting for 3.17% of the variance.

Both the t-test and the Mann-Whitney U test show a significant result. Therefore, I can conclude that there is a difference in the number of different technologies used between mature and non-mature students, with mature students using significantly fewer technologies than non-mature students.

A one-way ANOVA comparing the overall number of different technologies used for the different age brackets was carried out. Homogeneity of variance was assessed and found to be significant ($F(5,154)$ = 3.406, $p$ = 0.006), therefore the null hypothesis of equal variances can be rejected, and the variances are not equal. ANOVA is typically robust to non-equal variances, but only when the sample sizes are equal across groups (A. Field, 2005), and this is not the case for my data. Therefore, a Welch ANOVA was run, which accounts for non-equal variances.

Shapiro-Wilk tests were run to assess normality. The results are shown in Table 4.2.3. The age bracket 51-60 was not assessed since it only had one case. Three of the age brackets were found to be normal, however the other three were found to be non-normal. Since the assumption of normality is therefore violated, a Kruskal-Wallis test was also run as a non-parametric alternative.

The one-way Welch ANOVA shows that there is not a statistically significant difference between the different age brackets for number of different technologies used overall, with Welch's $F(5, 23.499)$ = 1.798, $p$ = 0.152. The effect size is small ($\eta^2$ = 0.091). Statistics are shown in Table 4.2.4.

**Table 4.2.3**
*Shapiro-Wilk test results for number of different technologies used overall between different age brackets*

| Age | df | Shapiro-Wilk | Significance |
|---|---|---|---|
| 18-21 | 71 | 0.87 | <0.001 *** |
| 22-25 | 41 | 0.85 | <0.001 *** |
| 26-30 | 18 | 0.87 | .019 * |
| 31-40 | 17 | 0.90 | .065 |
| 41-50 | 8 | 0.83 | .065 |
| 51-60 | 1 | . | . |
| 61-70 | 5 | 0.93 | .608 |

*Note.* * Significant at the 0.05 probability level
*** Significant at the 0.001 probability level

**Table 4.2.4**
*Statistics for number of different technologies used overall between different age brackets*

| Age | N | Mean | SD | Standard error | 95% confidence interval for mean | | Min | Max |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower bound | Upper bound | | |
| 18-21 | 71 | 21.3 | 2.2 | 0.3 | 20.8 | 21.8 | 15 | 24 |
| 22-25 | 41 | 20.7 | 3.5 | 0.5 | 19.6 | 21.8 | 9 | 24 |
| 26-30 | 18 | 20.1 | 2.9 | 0.7 | 18.7 | 21.6 | 13 | 23 |
| 31-40 | 17 | 20.7 | 2.2 | 0.5 | 19.6 | 21.8 | 17 | 24 |
| 41-50 | 8 | 20.4 | 4.3 | 1.5 | 16.8 | 24.0 | 12 | 24 |
| 51-60 | 1 | 19.0 | . | . | . | . | 19 | 19 |
| 61-70 | 5 | 16.4 | 4.0 | 1.8 | 11.4 | 21.4 | 10 | 21 |
| Total | 161 | 20.7 | 2.9 | 0.2 | 20.3 | 21.2 | 9 | 24 |

**Table 4.2.5**
*Ranks for Kruskal-Wallis H Test for number of different technologies used overall between mature and non-mature students*

| Age bracket | N | Median | Mean rank |
|---|---|---|---|
| 18-21 | 71 | 22.0 | 86.8 |
| 22-25 | 41 | 22.0 | 85.7 |
| 26-30 | 18 | 21.0 | 68.6 |
| 31-40 | 17 | 21.0 | 73.9 |
| 41-50 | 8 | 22.5 | 87.3 |
| 51-60 | 1 | 19.0 | 40.5 |
| 61-70 | 5 | 17.0 | 26.1 |
| Total | 161 | 22.0 | |

Prior to running the Kruskal-Wallis H test, the distributions of the different groups were inspected by box-plot and found to be similar. Median scores (shown in Table 4.2.5) were not significantly different between groups ($\chi^2(6)$ = 11.279, $p$ = 0.080). The effect size was again very small ($\eta^2_H$ = 0.034).

I also assessed whether there is a difference between different ages of mature student. Therefore a one-way ANOVA was run just for the mature age brackets (ages over 25). Homogeneity of variance was assessed and found to be non-significant ($F(3,44)$ = 1.991, $p$ = 0.129), therefore the variances are equal, so a Welch ANOVA is not required.

As we already know, three age groups (31-40, 41-50, and 61-70) are normal, one is excluded due to too few cases, but one (26-30) is not normal. It is therefore probable that ANOVA would be robust to this one instance of non-normality, but a Kruskal-Wallis H test was run in addition to the ANOVA just to make sure.

The ANOVA shows that there was not a statistically significant difference between the groups, $F(4, 44)$ = 2.005, $p$ = 0.110. The effect size is small ($\eta^2$ = 0.154). Therefore there appears to be no difference in how many different technologies the different ages of mature student use. The Kruskal-Wallis H test agrees that there is no significant difference ($\chi^2(4)$ = 6.576, $p$ = 0.160, $\eta^2_H$ = 0.059).

### 4.2.2 Number of Different Technologies Used For Course Activities

As well as looking at how many different technologies different groups of students used overall, I also want to look at how many different technologies are used for course activities only.

Levene's test of equality of variances showed that the variances for the two groups of mature and non-mature students for overall number of technologies used were the same ($F$ =1.596, $p$ = 0.208). The Shapiro-Wilk test for normality showed that both distributions were normal (Non-mature $D(112)$ = 0.981, $p$ < 0.122; Mature $D(49)$ = 0.972, $p$ < 0.292). An inspection of the Q-Q plots confirmed this. Therefore a t-test comparing the overall number of different technologies used for mature ($n$ = 49) and non-mature ($n$ = 112) students was carried out.

The t-test showed that mature students used fewer technologies for their course ($M$ = 12.76, $SD$ = 3.55) than their non-mature counterparts ($M$ = 13.88, $SD$ = 3.11), which was a statistically-significant difference, $M$ = 1.12, 95% CI [0.23, 2.22], $t(159)$ = 2.015, $p$ = 0.046. The effect size ($g$ = -0.348) is small.

A one-way ANOVA comparing the overall number of different technologies used for the different age brackets was carried out. Homogeneity of variance was assessed and found to be non-significant ($F(5,154)$ = 1.755, $p$ = 0.125). The significance is greater than 0.05, therefore the null hypothesis of equal variances cannot be rejected, and the variances are equal.

Shapiro-Wilk tests were run to assess normality. 51-60 was not assessed since it only had one case. All age brackets (18-21 ($D(71) = 0.980$, $p = 0.311$), 22-25 ($D(41) = 0.965$, $p = 0.227$), 26-30 ($D(18) = 0.922$, $p = 0.139$), 31-40 ($D(17) = 0.907$, $p = 0.089$), 41-50 ($D(8) = 0.914$, $p = 0.382$), 61-70 ($D(5) = 0.914$, $p = 0.492$)) were normal.

**Table 4.2.6**

*Statistics for number of different technologies used for course activities between different age brackets*

| Age | N | Mean | SD | Standard error | 95% confidence interval for mean | | Min | Max |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower bound | Upper bound | | |
| 18-21 | 71 | 13.9 | 3.2 | 0.4 | 13.1 | 14.6 | 7 | 21 |
| 22-25 | 41 | 13.9 | 3.0 | 0.5 | 13.0 | 14.9 | 8 | 19 |
| 26-30 | 18 | 12.6 | 3.1 | 0.7 | 11.1 | 14.2 | 8 | 17 |
| 31-40 | 17 | 12.2 | 3.6 | 0.9 | 10.4 | 14.1 | 6 | 17 |
| 41-50 | 8 | 15.0 | 5.0 | 1.8 | 10.9 | 19.1 | 8 | 21 |
| 51-60 | 1 | 12.0 | . | . | . | . | 12 | 12 |
| 61-70 | 5 | 11.6 | 1.5 | 0.7 | 9.7 | 13.5 | 10 | 14 |
| Total | 161 | 13.5 | 3.3 | 0.3 | 13.0 | 14.0 | 6 | 21 |

The ANOVA shows a non-significant result, $F(6, 154) = 1.510$, $p = 0.178$, $\eta^2 = 0.06$. Therefore, there appears to be no difference in the number of different technologies used for course activities between different age brackets. Statistics are shown in Table 4.2.6.

However, I want to also find whether there's a difference between different ages of mature student. Therefore another ANOVA was run just for the mature age brackets. Homogeneity of variance was assessed and found to be non-significant ($F(3,44) = 2.636$, $p = 0.061$). The significance is greater than 0.05, therefore the null hypothesis of equal variances cannot be rejected, and the variances are equal.

This ANOVA also shows a non-significant result, $F(4, 44) = 1.049$, $p = 0.393$, $\eta^2 = 0.09$. Therefore, there appears to also be no difference in the number of different technologies used for course activities between different age brackets of mature students, as well as over all of the age brackets. Statistics are shown in Table 4.2.7.

**Table 4.2.7**
*Statistics for number of different technologies used for course activities between different age brackets of mature students*

| Age | N | Mean | SD | Standard error | 95% confidence interval for mean | | Min | Max |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower bound | Upper bound | | |
| 26-30 | 18 | 12.6 | 3.1 | 0.7 | 11.1 | 14.2 | 8 | 17 |
| 31-40 | 17 | 12.2 | 3.6 | 0.9 | 10.4 | 14.1 | 6 | 17 |
| 41-50 | 8 | 15.0 | 5.0 | 1.8 | 10.9 | 19.1 | 8 | 21 |
| 51-60 | 1 | 12.0 | . | . | . | . | 12 | 12 |
| 61-70 | 5 | 11.6 | 1.5 | 0.7 | 9.7 | 13.5 | 10 | 14 |
| Total | 49 | 12.8 | 3.5 | 0.5 | 11.7 | 13.8 | 6 | 21 |

### 4.2.3 Number of Different Technologies Used For Non-Course Activities

Levene's test of equality of variances showed that the variances for the two groups of mature and non-mature students for overall number of technologies used were the same ($F$ = 0.143, $p$ = 0.706). However, the Shapiro-Wilk test for normality showed that neither distribution was normal (Non-mature $D(112)$ = 0.823, $p$ < 0.001; Mature $D(49)$ = 0.881, $p$ < 0.001). An inspection of the Q-Q plots confirmed this. Therefore, even though the sample sizes are greater than 25, they are not equal, so the assumption of normality for a t-test is violated. Therefore a Mann-Whitney U test in addition to a t-test comparing the overall number of different technologies used for mature and non-mature students was carried out.

The t-test shows a non-significant result, $M$ = 0.89, 95% CI [-0.59, 2.38], $t(159)$ = 1.188, $p$ = 0.237, $g$ = 0.202. Therefore, there is no difference in the number of different technologies used for non-course activities between mature ($M$ = 17.43, $SD$ = 4.37) and non-mature ($M$ = 18.32, $SD$ = 4.43) students.

For the Mann-Whitney test, the distributions of the two groups were assessed by visual inspection, and found to be dissimilar. The difference in the number of different technologies used by mature (mean rank = 73.13) and non-mature (mean rank = 84.44) students was found to be non-significant ($U$ = 2358, $z$ = -1.425, $p$ = 0.154), with no difference in the number of technologies used for non-course activities between mature and non-mature students. The effect size for the Mann-Whitney test is small ($r$ = -0.112).

A one-way ANOVA comparing the overall number of different technologies used for the different age brackets was carried out. Homogeneity of variance was assessed and found to be significant ($F(5,154)$ = 3.831, $p$ = 0.003). The significance is less than 0.05, therefore the null hypothesis of equal variances is rejected, and the variances are not equal. Therefore, a Welch test was run.

Shapiro-Wilk tests were run to assess normality. 51-60 was not assessed since it only had one case. The age brackets of 18-21 ($D(71)$ = 0.901, $p$ < 0.001), 22-25

($D$(41) = 0.843, $p$ < 0.001), 26-30 ($D$(18) = 0.839, $p$ = 0.006), and 31-40 ($D$(17) = 0.765, $p$ = 0.001) show non-normality. Ages of 41-50 ($D$(8) = 0.946, $p$ = 0.675) and 61-70 ($D$(5) = 0.967, $p$ = 0.852) are normal. Although ANOVA is robust to non-normality, I have also run a Kruskal-Wallis to compare the result with. Statistics are shown in Table 4.2.8.

**Table 4.2.8**

*Statistics for number of different technologies used for non-course activities between different age brackets*

| Age | N | Mean | SD | Standard error | 95% confidence interval for mean | | Min | Max |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower bound | Upper bound | | |
| 18-21 | 71 | 19.0 | 2.9 | 0.3 | 18.3 | 19.7 | 10 | 23 |
| 22-25 | 41 | 17.2 | 6.0 | 0.9 | 15.3 | 19.1 | 0 | 24 |
| 26-30 | 18 | 17.7 | 3.9 | 0.9 | 15.7 | 19.6 | 8 | 22 |
| 31-40 | 17 | 18.7 | 4.7 | 1.2 | 16.2 | 21.1 | 5 | 23 |
| 41-50 | 8 | 16.3 | 4.8 | 1.7 | 12.2 | 20.3 | 8 | 23 |
| 51-60 | 1 | 18.0 | . | . | . | . | 18 | 18 |
| 61-70 | 5 | 14.2 | 4.1 | 1.8 | 9.1 | 19.3 | 8 | 19 |
| Total | 161 | 18.1 | 4.4 | 0.3 | 17.4 | 18.7 | 0 | 24 |

**Table 4.2.9**

*Ranks for Kruskal-Wallis H Test for number of different technologies used for non-course activities between mature and non-mature students*

| Age bracket | N | Mean rank |
|---|---|---|
| 18-21 | 71 | 86.9 |
| 22-25 | 41 | 80.2 |
| 26-30 | 18 | 72.2 |
| 31-40 | 17 | 93.7 |
| 41-50 | 8 | 57.8 |
| 51-60 | 1 | 61.0 |
| 61-70 | 5 | 33.5 |
| Total | 161 | |

The ANOVA (Welch's $F$(6, 154) = 2.101, $p$ = 0.117, $\eta^2$ = 0.06) and the Kruskal-Wallis ($\chi^2$(6) = 10.531, $p$ = 0.104, $\eta^2_H$ = 0.03) show non-significant results (Table 4.2.9). Therefore, there appears to be no difference in the number of different technologies used for non-course activities between different age brackets.

However, I want to also find whether there's a difference between different ages of mature student. Therefore another ANOVA was run just for the mature age brackets. Homogeneity of variance was assessed and found to be non-significant ($F$(3,44) = 0.191, $p$ = 0.902). The significance is greater than 0.05, therefore the null hypothesis of equal variances cannot be rejected, and the variances are equal.

**Table 4.2.10**

*Statistics for number of different technologies used for non-course activities between different age brackets of mature students*

| Age | N | Mean | SD | Standard error | 95% confidence interval for mean | | Min | Max |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower bound | Upper bound | | |
| 26-30 | 18 | 17.7 | 3.9 | 0.9 | 15.7 | 19.6 | 8 | 22 |
| 31-40 | 17 | 18.7 | 4.7 | 1.2 | 16.2 | 21.1 | 5 | 23 |
| 41-50 | 8 | 16.3 | 4.8 | 1.7 | 12.2 | 20.3 | 8 | 23 |
| 51-60 | 1 | 18.0 | . | . | . | . | 18 | 18 |
| 61-70 | 5 | 14.2 | 4.1 | 1.8 | 9.1 | 19.3 | 8 | 19 |
| Total | 49 | 17.4 | 4.4 | 0.6 | 16.2 | 18.7 | 5 | 23 |

**Table 4.2.11**

*Ranks for Kruskal-Wallis H Test for number of different technologies used for non-course activities between different age brackets of mature students*

| Age bracket | N | Mean rank |
|---|---|---|
| 26-30 | 18 | 25.1 |
| 31-40 | 17 | 30.9 |
| 41-50 | 8 | 20.4 |
| 51-60 | 1 | 22.0 |
| 61-70 | 5 | 12.5 |
| Total | 49 | |

The ANOVA ($F(4, 44) = 1.159$, $p = 0.342$, $\eta^2 = 0.10$) and the Kruskal-Wallis ($\chi^2(4) = 7.611$, $p = 0.107$, $\eta^2_H = 0.08$) show non-significant results (Table 4.2.11). Therefore, there appears to be no difference in the number of different technologies used for non-course activities between different age brackets of mature student. Statistics are shown in Table 4.2.10.

Overall, mature students use fewer technologies than non-mature students. They also use fewer technologies for course-related activities. It is interesting that no difference was found in the number of technologies for non-course or personal activities, as it means that mature students are choosing to use the same number of technologies in their personal lives as younger students. This suggests that the stereotype of mature students being scared of technology may not be well-founded.

## 4.3 Frequency of Use of Technology

A Mann-Whitney U test was run to compare differences in the median frequency of use of technology between mature ($n$ = 49) and non-mature ($n$ = 112) students. Distributions of the two groups were assessed by visual inspection, and found to be dissimilar. Frequency of use of technology for mature (mean rank = 91.86) and non-mature (mean rank = 76.25) students were found to be statistically significant ($U$ = 2212, $z$ = -2.176, $p$ = 0.030). Due to the direction of the question, lower codes mean that technology is used more often (see coding scheme in Table 3.4.3 in the Methods), therefore mature students having a higher rank means that they use technology less often. However, the effect size is small ($r$ = -0.171), with age accounting for 2.94% of the variance in frequency of use.

To compare across the different age brackets, I ran a Kruskal-Wallis H test. The ranks and number of cases in each group are shown in Table 4.3.1.

**Table 4.3.1**
*Ranks from Kruskal-Wallis H Test for frequency of use*

| Age bracket | N | Mean rank |
|---|---|---|
| 18-21 | 71 | 78.1 |
| 22-25 | 41 | 73.0 |
| 26-30 | 18 | 96.1 |
| 31-40 | 17 | 85.2 |
| 41-50 | 8 | 79.6 |
| 51-60 | 1 | 36.5 |
| 61-70 | 5 | 130.2 |
| Total | 161 | |

**Table 4.3.2**
*Test statistics for Mann-Whitney U Tests between adjacent pairs of age brackets for frequency of use*

| Comparison between age brackets | | | | Mann-Whitney U | Significance |
|---|---|---|---|---|---|
| Age 1 | n | Age 2 | n | | |
| 18-21 | 71 | 22-25 | 41 | 1364.00 | 0.538 |
| 22-25 | 41 | 26-30 | 18 | 262.00 | 0.042 * |
| 26-30 | 18 | 31-40 | 17 | 134.50 | 0.489 |
| 31-40 | 17 | 41-50 | 8 | 63.50 | 0.771 |
| 41-50 | 8 | 51-60 | 1 | 2.00 | 0.394 |
| 51-60 | 1 | 61-70 | 5 | 0.00 | 0.137 |

*Note*. * Significant at the 0.05 probability level

The Kruskal-Wallis H Test for frequency of use across all age brackets was not significant ($\chi^2(6)$ = 12.355, $p$ = 0.055, $\eta^2_H$ = 0.04). A closer look at the Mann-

Whitney U tests (Table 4.3.2) between adjacent pairs of age brackets showed significant results between the 22-25 and 26-30 age ranges ($p$ = 0.042).

A Kruskal-Wallis was also used to look at the differences between the mature age groups only, and this was also non-significant ($\chi^2(4) = 7.168$, $p = 0.127$, $\eta^2_H$ = 0.072).

## 4.4 Length of Time of Use of Technology

A Mann-Whitney U Test found that the length of time of use of technology for mature (mean rank = 121.33) and non-mature (mean rank = 63.36) students were found to be statistically significant ($U = 768$, $z = -7.726$, $p < 0.001$). Mature students have a higher rank, meaning that they have used each technology for a longer period of time over their lives. The effect size for this is large ($r$ = -0.609).

**Table 4.4.1**

*Ranks for Kruskal-Wallis H Test for length of time of use*

| Age bracket | N | Mean rank |
|---|---|---|
| 18-21 | 71 | 56.5 |
| 22-25 | 41 | 75.2 |
| 26-30 | 18 | 114.9 |
| 31-40 | 17 | 120.7 |
| 41-50 | 8 | 128.0 |
| 51-60 | 1 | 128.0 |
| 61-70 | 5 | 134.6 |
| Total | 161 | |

The Kruskal-Wallis H Test (Table 4.4.1) for frequency of use across all age brackets was significant ($\chi^2(6) = 65.507$, $p < 0.001$). The effect size was medium ($\eta^2_H = 0.39$).

A closer look at the Mann-Whitney U tests (Table 4.4.2) between adjacent pairs of age brackets showed significant results between the 18-21 and 22-25 age ranges ($p$ = 0.033) and the 22-25 and 26-30 age ranges ($p$ = 0.002).

Across the mature age brackets only, the Kruskal-Wallis H test was non-significant ($\chi^2(4) = 5.553$, $p = 0.235$, $\eta^2_H = 0.035$), indicating that the difference does indeed lie between mature and non-mature students, as I have defined them.

**Table 4.4.2**
*Test statistics for Mann-Whitney U Tests between adjacent pairs of age brackets for length of time of use*

| Comparison between age brackets | | | | Mann-Whitney U | Significance |
|---|---|---|---|---|---|
| Age 1 | n | Age 2 | n | | |
| 18-21 | 71 | 22-25 | 41 | 1131.00 | 0.033 * |
| 22-25 | 41 | 26-30 | 18 | 191.00 | 0.002 ** |
| 26-30 | 18 | 31-40 | 17 | 144.50 | 0.687 |
| 31-40 | 17 | 41-50 | 8 | 56.00 | 0.215 |
| 41-50 | 8 | 51-60 | 1 | 4.00 | 1.000 |
| 51-60 | 1 | 61-70 | 5 | 2.00 | 0.655 |

*Note.* * Significant at the 0.05 probability level
** Significant at the 0.01 probability level

## 4.5 Attitudes

### 4.5.1 Preliminary Exploratory Factor Analysis

A preliminary exploratory factor analysis (EFA) was carried out on the attitudinal data in order to identify the factors to be extracted and for data reduction. The EFA used an oblique promax rotation with kappa = 4 (SPSS default).

I used Horn's parallel analysis to determine how many factors to extract. The analysis was run over 5000 simulations, with eigenvalues corresponding to the 95% percentile (151 cases, 31 variables). The results are shown in Table 4.5.1.

Therefore, from the parallel analysis, I can see there are three factors to extract. An exploratory factor analysis (EFA) was run using SPSS, with the method of principal axis factoring, with promax rotation and suppression of loadings less than 0.4.

The sample size was 151, with 10 cases excluded from the original 161 due to missing values. By examining the communalities in Table 4.5.2, I can see that they are broadly high (>0.6) or in the region of 0.5. The factors are highly over-determined, so with a sample between 100 and 200, this sample size is sufficient to achieve a good recovery of population factors (MacCallum et al., 1999).

**Table 4.5.1**

*Preliminary main study: Raw data eigenvalues, and mean and 95th percentile data eigenvalues from random permutations*

| Root | Raw data | Means | Percentile |
|---|---|---|---|
| 1.00 | 11.96 * | 1.96 | 2.10 |
| 2.00 | 3.74 * | 1.82 | 1.92 |
| 3.00 | 2.02 * | 1.72 | 1.80 |
| 4.00 | 1.62 | 1.63 | 1.70 |
| 5.00 | 1.21 | 1.55 | 1.62 |
| 6.00 | 1.05 | 1.48 | 1.54 |
| 7.00 | 0.90 | 1.41 | 1.47 |
| 8.00 | 0.84 | 1.35 | 1.40 |
| 9.00 | 0.74 | 1.29 | 1.34 |
| 10.00 | 0.64 | 1.23 | 1.28 |
| 11.00 | 0.58 | 1.18 | 1.22 |
| 12.00 | 0.56 | 1.13 | 1.17 |
| 13.00 | 0.51 | 1.08 | 1.12 |
| 14.00 | 0.47 | 1.03 | 1.07 |
| 15.00 | 0.43 | 0.98 | 1.02 |
| 16.00 | 0.42 | 0.94 | 0.98 |
| 17.00 | 0.38 | 0.89 | 0.93 |
| 18.00 | 0.36 | 0.85 | 0.89 |
| 19.00 | 0.32 | 0.81 | 0.85 |
| 20.00 | 0.29 | 0.77 | 0.81 |
| 21.00 | 0.27 | 0.73 | 0.77 |
| 22.00 | 0.25 | 0.69 | 0.73 |
| 23.00 | 0.23 | 0.65 | 0.69 |
| 24.00 | 0.23 | 0.61 | 0.65 |
| 25.00 | 0.22 | 0.58 | 0.61 |
| 26.00 | 0.17 | 0.54 | 0.58 |
| 27.00 | 0.15 | 0.50 | 0.54 |
| 28.00 | 0.12 | 0.46 | 0.50 |
| 29.00 | 0.12 | 0.43 | 0.46 |
| 30.00 | 0.10 | 0.38 | 0.42 |
| 31.00 | 0.08 | 0.34 | 0.38 |

*Note*. * denotes where raw data eigenvalue is larger than the eigenvalue of the 95th percentile – statistically significant at the 0.05 significance level

**Table 4.5.2**
*Preliminary main study: Communalities; extraction method of principal axis factoring*

| | Initial | Extraction |
|---|---|---|
| Technology can help me organise my studies | .545 | .374 |
| Technology allows me to learn wherever I need to | .522 | .266 |
| Technology allows students to learn at their own pace | .518 | .347 |
| I learn more rapidly when I use technology | .592 | .482 |
| Most things that one can do with technology can be done through other means | .226 | .045 |
| It takes longer to learn to use technology than to do the job manually | .506 | .355 |
| Technology makes my study activities more personal and my own | .448 | .274 |
| I like using technology | .745 | .655 |
| The use of technology increases my motivation to study | .655 | .541 |
| The use of technology makes a course more interesting | .630 | .505 |
| Technology stops me from being bored | .400 | .351 |
| I am tired of using technology | .502 | .417 |
| I am good at using technology | .843 | .815 |
| I find it easy to get technology to do what I want it to do | .809 | .763 |
| Technology makes me uncomfortable | .737 | .685 |
| I find technology confusing | .766 | .701 |
| I generally feel confident working with technology | .873 | .841 |
| I am easily able to learn new technology skills | .866 | .861 |
| I feel comfortable using technology | .839 | .792 |
| I am most confident with the forms of technology I am most familiar with | .414 | .231 |
| When I use computers, I feel in control | .679 | .620 |
| I am comfortable using technology I have chosen in my home | .616 | .490 |
| Technology makes me nervous | .738 | .677 |
| Technology makes me feel stupid | .755 | .691 |
| Using technology in my home makes me anxious, even if I have chosen it | .666 | .637 |
| I would like to know more about technology generally | .664 | .277 |
| Technology is fascinating | .612 | .476 |
| I only use technology when told to | .722 | .667 |
| I don't want to know more about technology | .721 | .504 |
| I feel I need more training to use technology properly | .578 | .442 |
| I need an experienced person nearby when I use technology | .725 | .667 |

**Table 4.5.3**

*Preliminary main study: Rotated pattern matrix by principal axis factoring, with promax rotation and Kaiser normalisation; rotation converged in 6 iterations*

| | Factor | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| I am good at using technology | 1.017 | | |
| I am easily able to learn new technology skills | 1.016 | | |
| I generally feel confident working with technology | .971 | | |
| I find it easy to get technology to do what I want it to do | .908 | | |
| I feel comfortable using technology | .884 | | |
| I am comfortable using technology I have chosen in my home | .683 | | |
| When I use computers, I feel in control | .620 | | |
| I need an experienced person nearby when I use technology | .492 | | .483 |
| I feel I need more training to use technology properly | .465 | | |
| I am most confident with the forms of technology I am most familiar with | | | |
| The use of technology increases my motivation to study | | .727 | |
| The use of technology makes a course more interesting | | .712 | |
| I learn more rapidly when I use technology | | .699 | |
| Technology can help me organise my studies | | .593 | |
| Technology allows students to learn at their own pace | | .575 | |
| Technology stops me from being bored | | .561 | |
| I would like to know more about technology generally | | .527 | |
| Technology allows me to learn wherever I need to | | .501 | |
| Technology makes my study activities more personal and my own | | .456 | |
| Technology is fascinating | | .452 | |
| I like using technology | | .416 | |
| Using technology in my home makes me anxious, even if I have chosen it | | | .735 |
| I don't want to know more about technology | | | .645 |
| Technology makes me uncomfortable | | | .642 |
| Technology makes me nervous | | | .611 |
| I only use technology when told to | | | .576 |
| Technology makes me feel stupid | .430 | | .530 |
| I find technology confusing | .472 | | .504 |
| I am tired of using technology | | | .494 |
| It takes longer to learn to use technology than to do the job manually | | | |
| Most things that one can do with technology can be done through other means | | | |

**Table 4.5.4**
*Preliminary main study: Rotated structure matrix by principal axis factoring, with promax rotation and Kaiser normalisation*

| | Factor | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| I am easily able to learn new technology skills | .918 | | .441 |
| I generally feel confident working with technology | .911 | | .466 |
| I am good at using technology | .888 | | .410 |
| I feel comfortable using technology | .880 | .418 | .483 |
| I find it easy to get technology to do what I want it to do | .867 | | .450 |
| When I use computers, I feel in control | .748 | .488 | .511 |
| I am comfortable using technology I have chosen in my home | .699 | | .442 |
| I like using technology | .666 | .621 | .597 |
| I feel I need more training to use technology properly | .593 | | .548 |
| I am most confident with the forms of technology I am most familiar with | .453 | | |
| The use of technology increases my motivation to study | | .735 | |
| The use of technology makes a course more interesting | | .711 | |
| I learn more rapidly when I use technology | | .693 | |
| Technology can help me organise my studies | | .597 | |
| Technology is fascinating | .502 | .591 | .475 |
| Technology allows students to learn at their own pace | | .583 | |
| Technology stops me from being bored | | .563 | |
| Technology allows me to learn wherever I need to | | .514 | |
| Technology makes my study activities more personal and my own | | .507 | |
| I would like to know more about technology generally | | .503 | |
| Technology makes me uncomfortable | .644 | | .801 |
| Technology makes me nervous | .663 | | .783 |
| Using technology in my home makes me anxious, even if I have chosen it | .534 | | .777 |
| I only use technology when told to | .674 | | .773 |
| Technology makes me feel stupid | .715 | | .761 |
| I find technology confusing | .731 | | .751 |
| I need an experienced person nearby when I use technology | .699 | | .709 |
| I don't want to know more about technology | | .482 | .596 |
| It takes longer to learn to use technology than to do the job manually | .489 | | .557 |
| I am tired of using technology | | .494 | .532 |
| Most things that one can do with technology can be done through other means | | | |

**Table 4.5.5**
*Preliminary main study: Factor correlation matrix by principal axis factoring with promax rotation and Kaiser normalisation*

| Factor | 1 | 2 | 3 |
|---|---|---|---|
| 1 | 1.000 | .353 | .597 |
| 2 | .353 | 1.000 | .296 |
| 3 | .597 | .296 | 1.000 |

Considering the pattern matrix in Table 4.5.3 and structure matrix in Table 4.5.4, some items should be removed (Matsunaga, 2010). Three items have no factor loadings over 0.4, so were discarded. One of these is also the item with the lowest communality, so the removal of this item improves the case for a sufficient sample size based on communalities around 0.5. Furthermore, three items loaded onto both factors with a difference of less than 0.4 between the primary and secondary loadings. These were also discarded (Matsunaga, 2010).

Following this item trimming, another exploratory factor analysis was run. This presented two further cases of items having no factor loadings over 0.4, which were removed. There were no cross-loadings in this run.

Finally, one more EFA was run, resulting in a final pattern matrix with no items with all loadings less than 0.4 on any factor, or any cross-loadings. This is the data that will presented in the results in order to compare attitudes between age groups. For this final EFA, the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.894, which is above the 0.5 that means factor analysis is considered suitable for this data (Williams et al., 2010), and in fact would be considered "good" (Parsian & Dunning, 2009). Bartlett's test of sphericity was significant ($\chi^2$ (253) = 2437.926, $p$<0.001) which also suggests the data is suitable for factor analysis (Williams et al., 2010).

**Table 4.5.6**

*Preliminary main study: Raw data eigenvalues, and mean and 95th percentile data eigenvalues from random permutations*

| Root | Raw data | Means | Percentile |
|---|---|---|---|
| 1.00 | 8.86 * | 1.77 | 1.91 |
| 2.00 | 3.29 * | 1.64 | 1.73 |
| 3.00 | 1.78 * | 1.54 | 1.62 |
| 4.00 | 1.43 | 1.45 | 1.52 |
| 5.00 | 1.00 | 1.37 | 1.44 |
| 6.00 | 0.83 | 1.30 | 1.36 |
| 7.00 | 0.75 | 1.24 | 1.29 |
| 8.00 | 0.60 | 1.18 | 1.23 |
| 9.00 | 0.54 | 1.12 | 1.17 |
| 10.00 | 0.50 | 1.06 | 1.11 |
| 11.00 | 0.46 | 1.01 | 1.05 |
| 12.00 | 0.42 | 0.96 | 1.00 |
| 13.00 | 0.37 | 0.91 | 0.95 |
| 14.00 | 0.36 | 0.86 | 0.90 |
| 15.00 | 0.31 | 0.81 | 0.85 |
| 16.00 | 0.27 | 0.76 | 0.81 |
| 17.00 | 0.25 | 0.72 | 0.76 |
| 18.00 | 0.25 | 0.67 | 0.71 |
| 19.00 | 0.22 | 0.63 | 0.67 |
| 20.00 | 0.16 | 0.58 | 0.62 |
| 21.00 | 0.14 | 0.53 | 0.58 |
| 22.00 | 0.11 | 0.48 | 0.53 |
| 23.00 | 0.09 | 0.42 | 0.48 |

*Note*: * denotes where raw data eigenvalue is larger than the eigenvalue of the 95th percentile – statistically significant at the 0.05 significance level

Although a preliminary parallel analysis was completed on earlier iterations of the scale, I used Horn's parallel analysis to check that the number of factors to extract hadn't changed from the preliminary analysis. The analysis was run over 5000 simulations, with eigenvalues corresponding to the 95% percentile (154 cases, 23 variables). The results are shown in Table 4.5.6.

Therefore, from the parallel analysis, I can see there are still three factors to extract. An exploratory factor analysis (EFA) was run using SPSS, with the method of principal axis factoring, with promax rotation and suppression of loadings less than 0.4.

The sample size was now 154, with 7 cases excluded from the original 161 due to missing values. Looking at the communalities in Table 4.5.7, they are broadly high (>0.6) or in the region of 0.5. The factors are highly over-determined, so with a sample between 100 and 200, this sample size is sufficient to achieve a good recovery of population factors (MacCallum et al., 1999).

**Table 4.5.7**

*Preliminary main study: Communalities; extraction method of principal axis factoring*

| | Initial | Extraction |
|---|---|---|
| Technology can help me organise my studies | .528 | .403 |
| Technology allows me to learn wherever I need to | .505 | .306 |
| Technology allows students to learn at their own pace | .503 | .390 |
| I learn more rapidly when I use technology | .545 | .525 |
| Technology makes my study activities more personal and my own | .408 | .281 |
| The use of technology increases my motivation to study | .607 | .559 |
| The use of technology makes a course more interesting | .588 | .490 |
| Technology stops me from being bored | .376 | .338 |
| I am tired of using technology | .454 | .389 |
| I am good at using technology | .826 | .811 |
| I find it easy to get technology to do what I want it to do | .790 | .764 |
| Technology makes me uncomfortable | .682 | .679 |
| I generally feel confident working with technology | .863 | .835 |
| I am easily able to learn new technology skills | .862 | .859 |
| I feel comfortable using technology | .833 | .801 |
| When I use computers, I feel in control | .659 | .616 |
| I am comfortable using technology I have chosen in my home | .594 | .503 |
| Technology makes me nervous | .673 | .695 |
| Using technology in my home makes me anxious, even if I have chosen it | .648 | .643 |
| I would like to know more about technology generally | .615 | .238 |
| I only use technology when told to | .646 | .659 |
| I don't want to know more about technology | .694 | .478 |
| I feel I need more training to use technology properly | .477 | .418 |

**Table 4.5.8**
*Preliminary main study: Rotated pattern matrix by principal axis factoring, with promax rotation and Kaiser normalisation; rotation converged in 6 iterations*

| | Factor | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| I am easily able to learn new technology skills | .954 | | |
| I am good at using technology | .948 | | |
| I generally feel confident working with technology | .914 | | |
| I find it easy to get technology to do what I want it to do | .855 | | |
| I feel comfortable using technology | .832 | | |
| I am comfortable using technology I have chosen in my home | .644 | | |
| When I use computers, I feel in control | .590 | | |
| I feel I need more training to use technology properly | .410 | | |
| The use of technology increases my motivation to study | | .737 | |
| I learn more rapidly when I use technology | | .734 | |
| The use of technology makes a course more interesting | | .703 | |
| Technology allows students to learn at their own pace | | .617 | |
| Technology can help me organise my studies | | .605 | |
| Technology stops me from being bored | | .546 | |
| Technology allows me to learn wherever I need to | | .528 | |
| I would like to know more about technology generally | | .462 | |
| Technology makes my study activities more personal and my own | | .462 | |
| Using technology in my home makes me anxious, even if I have chosen it | | | .790 |
| Technology makes me nervous | | | .687 |
| Technology makes me uncomfortable | | | .681 |
| I don't want to know more about technology | | | .641 |
| I only use technology when told to | | | .621 |
| I am tired of using technology | | | .464 |

**Table 4.5.9**
*Preliminary main study: Rotated structure matrix by principal axis factoring, with promax rotation and Kaiser normalisation*

| | Factor | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| I am easily able to learn new technology skills | .926 | | .486 |
| I generally feel confident working with technology | .914 | | .504 |
| I am good at using technology | .897 | | .454 |
| I feel comfortable using technology | .888 | | .540 |
| I find it easy to get technology to do what I want it to do | .870 | | .484 |
| When I use computers, I feel in control | .742 | .466 | .544 |
| I am comfortable using technology I have chosen in my home | .701 | | .474 |
| I feel I need more training to use technology properly | .562 | | .545 |
| The use of technology increases my motivation to study | | .747 | |
| I learn more rapidly when I use technology | | .723 | |
| The use of technology makes a course more interesting | | .699 | |
| Technology can help me organise my studies | | .620 | |
| Technology allows students to learn at their own pace | | .620 | |
| Technology allows me to learn wherever I need to | | .550 | |
| Technology stops me from being bored | | .548 | |
| Technology makes my study activities more personal and my own | | .512 | |
| I would like to know more about technology generally | | .463 | |
| Technology makes me nervous | .617 | | .807 |
| Technology makes me uncomfortable | .597 | | .804 |
| Using technology in my home makes me anxious, even if I have chosen it | .479 | | .784 |
| I only use technology when told to | .631 | | .776 |
| I don't want to know more about technology | | .451 | .602 |
| I am tired of using technology | | .481 | .529 |

From the pattern matrix in Table 4.5.8, I can see there are three factors. The first factor, onto which eight statements load, can be described as being about confidence using technology. The second factor has nine statements loading onto it, and can be described as being about the use of technology.

However, the third factor, with six statements, seems extremely similar in content to factor one. In fact, factor one seems to contain all of the positively-worded items about confidence, whereas factor three seems to contain all of the reverse-worded items about confidence. I included both positive and negative items in my survey in order to attempt to avoid acquiescence bias. However recent research has begun to find that this may lead to acquiescence bias in the factor structure, and therefore lead to "method factors" – extra factors that are artefacts caused by the methods used (in this case, using both positive- and negative-worded items) (Sonderen et al., 2013; Zhang et al., 2016). With factor one assessing confidence, and factor three assessing negatively-worded confidence items, factor three could be about aversion to technology. However, it seems to me that factors one and three assess the same confidence factor, just the positive and negative aspects of it, and therefore, I strongly suspect that one of these factors is such an artefact. This is supported by the rotation shown in Table 4.5.9, where many of the items load onto both factors one and three. I will therefore disregard factor three, and therefore also disregard the items that load onto it. This results in two final factors: confidence and use.

### 4.5.2 Final Exploratory Factor Analysis and Factor Determination

It has been found that sample size is sensitive to the ratio of variables to factors and communalities (Mundfrom et al., 2005). The recommendation is that there is a minimum variable-to-factor ratio of 7:1 for the agreement between sample and population factor structure to be considered "good". For this study, the variable-to-factor ratio was approximately 8:1. The level of communality was found to be "wide", ranging approximately between 0.2 and 0.8 (Mundfrom et al., 2005). Therefore, using Mundfrom et al.'s (2005) guidelines, the sample size for this study ($n$ = 161) easily met the criterion of a minimum sample of 65 participants for excellent agreement.

The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.888, which is above the 0.5 that means factor analysis is considered suitable for this data (Williams et al., 2010), and in fact would be considered "good" (Parsian & Dunning, 2009). Bartlett's test of sphericity was significant ($\chi^2$ (136) = 1712.280, $p < 0.001$) which also suggests the data is suitable for factor analysis (Williams et al., 2010).

**Table 4.5.10**
*Main study: Rotated pattern matrix by principal axis factoring, with promax rotation and Kaiser normalisation; rotation converged in 3 iterations*

| | Factor | |
|---|---|---|
| | 1 | 2 |
| I am easily able to learn new technology skills | .952 | |
| I am good at using technology | .926 | |
| I generally feel confident working with technology | .925 | |
| I feel comfortable using technology | .865 | |
| I find it easy to get technology to do what I want it to do | .840 | |
| I am comfortable using technology I have chosen in my home | .720 | |
| When I use computers, I feel in control | .672 | |
| I feel I need more training to use technology properly | .590 | |
| I learn more rapidly when I use technology | | .749 |
| The use of technology increases my motivation to study | | .729 |
| The use of technology makes a course more interesting | | .696 |
| Technology can help me organise my studies | | .663 |
| Technology allows students to learn at their own pace | | .646 |
| Technology allows me to learn wherever I need to | | .614 |
| Technology stops me from being bored | | .497 |
| Technology makes my study activities more personal and my own | | .468 |
| I would like to know more about technology generally | | .414 |

**Table 4.5.11**
*Main study: Rotated structure matrix by principal axis factoring, with promax rotation and Kaiser normalisation*

| | Factor | |
|---|---|---|
| | 1 | 2 |
| I am easily able to learn new technology skills | .929 | |
| I generally feel confident working with technology | .919 | |
| I feel comfortable using technology | .895 | .422 |
| I am good at using technology | .888 | |
| I find it easy to get technology to do what I want it to do | .865 | |
| When I use computers, I feel in control | .761 | .491 |
| I am comfortable using technology I have chosen in my home | .703 | |
| I feel I need more training to use technology properly | .552 | |
| I learn more rapidly when I use technology | | .731 |
| The use of technology increases my motivation to study | | .731 |
| The use of technology makes a course more interesting | | .684 |
| Technology allows students to learn at their own pace | | .648 |
| Technology can help me organise my studies | | .632 |
| Technology allows me to learn wherever I need to | | .600 |
| Technology stops me from being bored | | .533 |
| Technology makes my study activities more personal and my own | | .516 |
| I would like to know more about technology generally | | |

Two final attitudinal factors were found: factor one is defined as confidence, and factor two is defined as technology use (see Tables 4.5.10 and 4.5.11). These are the same two interpretations of factors as found in the pilot, which suggests that the evidence for the solution is strong (MacCallum et al., 1999).

The internal consistency of the attitudes section was assessed using Cronbach's alpha coefficient, and was calculated as 0.916, which is sufficiently high (Nunnally & Bernstein, 1994). For the individual subscales for each factor, the confidence factor has a Cronbach's alpha of 0.923, and the technology use factor is 0.825. The total variance explained by the confidence factor was 38.0%, and by the technology use factor was 14.6%, as shown in Table 4.5.12.

**Table 4.5.12**

*Main study: Total variance explained; extraction method is principal axis factoring*

| Factor | Initial Eigenvalues Total | Initial Eigenvalues % of Variance | Initial Eigenvalues Cumulative % | Extraction Sums of Squared Loadings Total | Extraction Sums of Squared Loadings % of Variance | Extraction Sums of Squared Loadings Cumulative % | Rotation Sums of Squared Loadings Total |
|---|---|---|---|---|---|---|---|
| 1 | 6.81 | 40.03 | 40.03 | 6.45 | 37.95 | 37.95 | 5.98 |
| 2 | 2.99 | 17.56 | 57.60 | 2.49 | 14.65 | 52.60 | 4.39 |
| 3 | 1.25 | 7.37 | 64.96 | | | | |
| 4 | 0.91 | 5.34 | 70.30 | | | | |
| 5 | 0.81 | 4.74 | 75.04 | | | | |
| 6 | 0.65 | 3.84 | 78.88 | | | | |
| 7 | 0.62 | 3.63 | 82.51 | | | | |
| 8 | 0.52 | 3.04 | 85.55 | | | | |
| 9 | 0.49 | 2.91 | 88.46 | | | | |
| 10 | 0.41 | 2.43 | 90.89 | | | | |
| 11 | 0.39 | 2.28 | 93.17 | | | | |
| 12 | 0.33 | 1.92 | 95.09 | | | | |
| 13 | 0.25 | 1.48 | 96.57 | | | | |
| 14 | 0.23 | 1.34 | 97.90 | | | | |
| 15 | 0.15 | 0.87 | 98.77 | | | | |
| 16 | 0.12 | 0.68 | 99.45 | | | | |
| 17 | 0.09 | 0.55 | 100.00 | | | | |

*Note.* When factors are correlated, sums of squared loadings cannot be added to obtain a total variance

### 4.5.3 Factor One: Confidence

Levene's test of equality of variances showed that the variances for the two groups of mature and non-mature students for overall number of technologies used were the same ($F$ = 2.360, $p$ = 0.126). However, the Shapiro-Wilk test for normality showed that neither distribution was normal (Non-mature $D$(112) = 0.888, $p$ < 0.001; Mature $D$(49) = 0.871, $p$ < 0.001). An inspection of the Q-Q plots confirmed this. Therefore, even though the sample sizes are greater than 25, they are not equal, so the assumption of normality for a t-test is violated. Therefore a Mann-Whitney U test in addition to a t-test comparing the factor one attitude, confidence, for mature and non-mature students was carried out.

The t-test shows a non-significant result ($M$ = 0.70, 95% CI [-0.07, 0.63], $t$(159) = 1.575, $p$ = 0.117, $g$ = 0.270) in the confidence attitude between mature ($M$ = 5.45, $SD$ = 1.22) and non-mature ($M$ = 5.73, $SD$ = 0.95) students. The Mann-Whitney U test also found a non-significant result ($U$ = 2431, $z$ = -1.152, $p$ = 0.249, $r$ = -

0.091) between mature (mean rank = 74.61) and non-mature (mean rank = 83.79) students.

A one-way ANOVA comparing the confidence attitude for the different age brackets was carried out. Homogeneity of variance was assessed and found to be non-significant ($F(5,154) = 1.208$, $p = 0.308$). The significance is greater than 0.05, therefore the null hypothesis of equal variances cannot be rejected, and the variances are equal.

Shapiro-Wilk tests were run to assess normality. 51-60 was not assessed since it only had one case. Age brackets 18-21 ($D(71) = 0.947$, $p = 0.004$), 22-25 ($D(41) = 0.756$, $p < 0.001$), 26-30 ($D(18) = 0.793$, $p = 0.001$), and 61-70 ($D(5) = 0.749$, $p = 0.029$) were not normal, whereas 31-40 ($D(17) = 0.947$, $p = 0.412$), 41-50 ($D(8) = 0.941$, $p = 0.616$) were normal. Since this violates the assumption of normality, Kruskal-Wallis tests were also run.

**Table 4.5.13**

*Main study: Ranks for Kruskal-Wallis H Test for the confidence factor*

| Age bracket | N | Mean rank |
|---|---|---|
| 18-21 | 71 | 81.6 |
| 22-25 | 41 | 87.6 |
| 26-30 | 18 | 86.2 |
| 31-40 | 17 | 75.2 |
| 41-50 | 8 | 47.9 |
| 51-60 | 1 | 95.5 |
| 61-70 | 5 | 69.6 |
| Total | 161 | |

The ANOVA ($F(6, 154) = 1.129$, $p = 0.348$, $\eta^2 = 0.04$) and the Kruskal-Wallis ($\chi^2(6) = 5.778$, $p = 0.449$, $\eta^2_H = 0.00$) show non-significant results in Table 4.5.13. Therefore, there appears to be no difference in the confidence between different age brackets. However, I want to also find whether there’s a difference between different ages of mature student. I therefore ran ANOVA and Kruskal-Wallis tests on just the mature age brackets, shown in Table 4.5.14. These were also non-significant, with both the ANOVA ($F(4, 44) = .758$, $p = 0.558$, $\eta^2 = 0.06$) and Kruskal-Wallis ($\chi^2(4) = 3.651$, $p = 0.455$, $\eta^2_H = -0.01$) showing no difference between the mature age groups.

**Table 4.5.14**

*Main study: Ranks for Kruskal-Wallis H Test for confidence for mature age brackets only*

| Age bracket | N | Mean rank |
|---|---|---|
| 26-30 | 18 | 28.2 |
| 31-40 | 17 | 25.4 |
| 41-50 | 8 | 17.4 |
| 51-60 | 1 | 33.0 |
| 61-70 | 5 | 22.8 |
| Total | 161 | |

### 4.5.4 Factor Two: How Students Use Technology

Levene's test of equality of variances showed that the variances for the two groups of mature and non-mature students for factor two, how students use technology, were the same ($F$ = 2.755, $p$ = 0.099). The Shapiro-Wilk test for normality showed that the distributions were normal (Non-mature $D$(112) = 0.986, $p$ = 0.324; Mature $D$(49) = 0.964, $p$ = 0.135). An inspection of the Q-Q plots confirmed this. Therefore the assumption of normality is upheld.

The t-test shows a non-significant result ($M$ = 0.15, 95% CI [-0.13, 0.42], $t$(159) = 1.037, $p$ = 0.302, $g$ = 0.177) in the usage attitude between mature ($M$ = 5.40, $SD$ = 0.92) and non-mature ($M$ = 5.55, $SD$ = 0.76) students. Therefore, there appears to be no difference in the technology use component between mature and non-mature students.

A one-way ANOVA comparing the usage attitude for the different age brackets was carried out. Homogeneity of variance was assessed and found to be non-significant ($F$(5,154) = 2.219, $p$ = 0.055). The significance is greater than 0.05, therefore the null hypothesis of equal variances cannot be rejected, and the variances are equal.

Shapiro-Wilk tests were run to assess normality. 51-60 was not assessed since it only had one case. All age brackets, 18-21 ($D$(71) = 0.985, $p$ = 0.548), 22-25 ($D$(41) = 0.975, $p$ = 0.504), 26-30 ($D$(18) = 0.928, $p$ = 0.175), 31-40 ($D$(5) = 0.956, $p$ = 0.566), 41-50 ($D$(17) = 0.963, $p$ = 0.839), 61-70 ($D$(8) = 0.283, $p$ = 0.284) were normal. Therefore the null hypothesis of normality could not be rejected, and an ANOVA is suitable.

The ANOVA ($F$(6, 154) = 2.159, $p$ = 0.050) shows a significant result, however this has a very small effect size of $\eta^2$ = 0.08. Thus there appears to be a small difference in usage attitude between different age brackets. Tukey's HSD post-hoc tests were run to investigate this difference further. The age bracket 51-60 was excluded from the analysis as for post-hoc tests, all groups needed to have more than one case. Following this exclusion, the ANOVA became more significant ($F$(4, 44) = 2.590, $p$ = 0.028) but the effect size was still small ($\eta^2$ = 0.08). Tukey post-hoc testing revealed significant differences between the age groups pairs of 26-30 and 61-70 ($p$ = 0.040), and also between 41-50 and 61-70 ($p$ = 0.041).

However, I want to also find whether there's a difference between different ages of mature student. The homogeneity of variance was found to be significant ($F$(3,444) = 3.051, $p$ = 0.038), and therefore the null hypothesis of equal variances can be rejected, and the variances are not equal. A Welch test was therefore also run in an ANOVA on just the mature age brackets. The ANOVA for these ages is also non-significant (Welch's $F$(3, 44) = 2.839, $p$ = 0.075, $\eta^2$ = 0.14), showing no difference between the mature age groups.

### 4.5.5 Overall Attitude

Levene's test of equality of variances showed that the variances for the two groups of mature and non-mature students for overall means were the same ($F$ = 2.079, $p$ = 0.151). The Shapiro-Wilk test for normality showed that the distributions were not normal (Non-mature $D$(112) = 0.965, $p$ = 0.005; Mature $D$(49) = 0.936, $p$ = 0.011). An inspection of the Q-Q plots confirmed this. Therefore the assumption of normality is broken, and additional Mann-Whitney U tests were also run in addition to a t-test.

The t-test shows a non-significant result ($M$ = 0.20, 95% CI [-0.05, 0.46], $t$(159) = 1.556, $p$ = 0.122, $g$ = 0.266) in the overall attitude between mature ($M$ = 5.43, $SD$ = 0.84) and non-mature ($M$ = 5.63, $SD$ = 0.72) students. The Mann-Whitney U test also found a non-significant result ($U$ = 2433.5, $z$ = -1.141, $p$ = 0.254, $r$ = -0.090) between mature (mean rank = 74.66) and non-mature (mean rank = 83.77) students. Therefore, there appears to be no difference in the overall attitude between mature and non-mature students.

A one-way ANOVA comparing the overall means for the different age brackets was carried out. Homogeneity of variance was assessed and found to be non-significant ($F$(5,154) = 0.578, $p$ = 0.716). The significance is greater than 0.05, therefore the null hypothesis of equal variances cannot be rejected, and the variances are equal.

Shapiro-Wilk tests were run to assess normality. 51-60 was not assessed since it only had one case. The age bracket 22-25 ($D$(41) = 0.894, $p$ = 0.001) was not normal, but 18-21 ($D$(71) = 0.978, $p$ = 0.259), 26-30 ($D$(18) = 0.913, $p$ = 0.095), 31-40 ($D$(17) = 0.946, $p$ = 0.392), 41-50 ($D$(8) = 0.823, $p$ = 0.051), and 61-70 ($D$(5) = 0.881, $p$ = 0.313) were normal. Due to one group violating the assumption of normality, a Kruskal-Wallis H test was run in addition to the ANOVA. The results are shown in Table 4.5.15.

The ANOVA ($F$(6, 154) = 1.359, $p$ = 0.235, $\eta^2$ = 0.05) and the Kruskal-Wallis ($\chi^2$(6) = 6.664, $p$ = 0.353, $\eta^2_H$ = 0.00) show non-significant results. Therefore, there appears to be no difference in overall attitude between different age brackets.

**Table 4.5.15**
*Main study: Ranks for Kruskal-Wallis H Test for overall attitude*

| Age bracket | N | Mean rank |
|---|---|---|
| 18-21 | 71 | 78.4 |
| 22-25 | 41 | 93.1 |
| 26-30 | 18 | 83.1 |
| 31-40 | 17 | 71.0 |
| 41-50 | 8 | 78.9 |
| 51-60 | 1 | 93.5 |
| 61-70 | 5 | 46.3 |
| Total | 161 | |

However, I want to also find whether there's a difference between different ages of mature student. The homogeneity of variance was found to be non-significant ($F$(3,44) = 0.324, $p$ = 0.808). The ANOVA for these ages is also non-significant ($F$(4, 44) = 0.904, $p$ = 0.470, $\eta^2$ = 0.08), showing no difference between the mature age groups.

### 4.5.6 Individual Items

Mann-Whitney U tests were carried out on the individual items of the Likert scale to see if there were any particular items that showed a significant difference between mature and non-mature students. The results are shown in Table 4.5.16.

Two items were identified as significant: "I feel I need more training to use technology properly", and "Technology stops me from being bored".

For the first item, "I feel I need more training to use technology properly", mature students (mean rank = 69.99) were found to have a lower rank (i.e., higher disagreement with the statement) than non-mature students (mean rank = 85.82), indicating that it is actually non-mature students who feel they need more training to use technology ($U$ = 2204.5, $z$ = -2.011, $p$ = 0.044). The effect size for this is small ($r$ = -0.158).

For the second item, "Technology stops me from being bored", mature students (mean rank = 86.93) were found to have a lower rank (i.e., higher disagreement with the statement) than non-mature students (mean rank = 65.94), indicating that mature students feel that technology is less likely to stop them being bored ($U$ = 2006, $z$ = -2.712, $p$ = 0.007). The effect size for this is small ($r$ = -0.214). It is also possible that this question could be interpreted in such a way that the implication is that mature students don't feel they need technology to stop being bored.

I also carried out Mann-Whitney U tests on the individual items that were included in the final questionnaire but removed through the exploratory factor analysis process. This was done in case the removed items represented a significant section of a difference between mature and non-mature students, which is why they were not encapsulated by the factor analysis. The results are shown in Table 4.5.17. It was found that none of the removed cases are significant.

**Table 4.5.16**

*Main study: Test statistics for Mann-Whitney U Test on individual Likert items, with the grouping variable as mature or non-mature*

| | Mann-Whitney U Test | |
|---|---|---|
| | U | Sig. |
| I am easily able to learn new technology skills | 2508.00 | .469 |
| I am good at using technology | 2721.50 | .930 |
| I generally feel confident working with technology | 2669.00 | .939 |
| I feel comfortable using technology | 2466.50 | .428 |
| I find it easy to get technology to do what I want it to do | 2638.00 | .677 |
| I am comfortable using technology I have chosen in my home | 2327.00 | .129 |
| When I use computers, I feel in control | 2189.50 | .051 |
| I feel I need more training to use technology properly | 2204.50 | .044 * |
| I learn more rapidly when I use technology | 2559.50 | .486 |
| The use of technology increases my motivation to study | 2659.50 | .893 |
| The use of technology makes a course more interesting | 2362.00 | .172 |
| Technology can help me organise my studies | 2491.50 | .298 |
| Technology allows students to learn at their own pace | 2643.50 | .693 |
| Technology allows me to learn wherever I need to | 2522.00 | .419 |
| Technology stops me from being bored | 2006.00 | .007 ** |
| Technology makes my study activities more personal and my own | 2656.50 | .741 |
| I would like to know more about technology generally | 2370.50 | .259 |

*Note.* * Significant at the 0.05 probability level
** Significant at the 0.01 probability level

**Table 4.5.17**

*Main study: Test statistics for Mann-Whitney U Test on removed individual Likert items, with the grouping variable as mature or non-mature*

| | Mann-Whitney U Test | |
|---|---|---|
| | U | Sig. |
| Technology makes my study activities more personal and my own | 2656.50 | .741 |
| Using technology in my home makes me anxious, even if I have chosen it | 2592.50 | .696 |
| Technology makes me nervous | 2649.00 | .878 |
| Technology makes me uncomfortable | 2649.50 | .714 |
| I don't want to know more about technology | 2336.00 | .139 |
| I only use technology when told to | 2584.00 | .530 |
| I am tired of using technology | 2598.00 | .584 |
| Most things that one can do with technology can be done through other means | 2440.50 | .374 |
| It takes longer to learn to use technology than to do the job manually | 2671.50 | .928 |
| I like using technology | 2401.50 | .208 |
| I find technology confusing | 2679.00 | .803 |
| I am most confident with the forms of technology I am most familiar with | 2505.50 | .457 |
| Technology makes me feel stupid | 2488.00 | .434 |
| Technology is fascinating | 2346.00 | .127 |
| I need an experienced person nearby when I use technology | 2627.00 | .652 |

## 4.6 Qualitative Open-Text Comments

12 out of 161 respondents (7.45%) left comments in the open-text box. Overall, three comments were positive about technology, four were negative, four had both positive and negative aspects, and one was a comment on the contents of the questionnaire. The comment on the questionnaire contents (which suggested an additional demographic) was disregarded from this analysis because it did not provide insight into the student's experience of technology.

A thematic analysis was conducted on the qualitative comments, following Braun and Clarke's (2006) six-step process. All demographics except the 22-25 and 51-60 age groups, and the medicine discipline, were represented, although the sample sizes are extremely small. The participant demographics are shown in Table 4.6.1. Giving open-text comments was optional, so the comments are unlikely to give a full picture of the attitude of the participant. Most comments are only a sentence or two long. On that basis, this brief analysis will enable an overview or flavour of some of the more detailed views behind technology adoption, and will be useful to put some of the previous results into context. The comments have been analysed independently from the participants who volunteered to be interviewed.

Nine codes were identified from the comments, which were grouped into three themes, as shown in Table 4.6.2. It is interesting that two of these are identical themes to those that arose from the factor analysis. Tables 4.6.3, 4.6.4, and 4.6.5 show which codes were common amongst the different demographics, and Tables 4.6.6, 4.6.7 and 4.6.8 show how each demographic talked about each theme.

**Table 4.6.1**
*Participant demographics for the open-text comments*

| Participant number | Age bracket | Discipline | Full time (FT) or part time (PT) |
|---|---|---|---|
| 1 | 18-21 | Arts and humanities | FT |
| 2 | 18-21 | The sciences | PT |
| 3 | 26-30 | Social sciences | FT |
| 4 | 26-30 | Arts and humanities | FT |
| 5 | 31-40 | Social sciences | FT |
| 6 | 31-40 | Arts and humanities | FT |
| 7 | 31-40 | The sciences | PT |
| 8 | 41-50 | Social sciences | FT |
| 9 | 41-50 | Engineering | PT |
| 10 | 41-50 | Social sciences | PT |
| 11 | 61-70 | Social sciences | FT |
| 12 | 61-70 | Arts and humanities | PT |

**Table 4.6.2**
*Themes generated from the coded open-text comments*

| Code | Theme |
|---|---|
| Usefulness<br>Reliability<br>Making tasks harder<br>Necessity<br>Distraction | Utility |
| Training/support<br>Technology constantly changing | Knowledge |
| Apprehension<br>Overwhelming | Confidence |

**Table 4.6.3**
*Codes for different ages of student for open-text comments*

| | Distraction | Usefulness | Training | Constantly changing | Makes life harder | Incompatibility | Reliability | Overwhelming | Apprehension |
|---|---|---|---|---|---|---|---|---|---|
| 18-21 (*n* = 2) | ✔ | ✔ | | | ✔ | | ✔ | ✔ | |
| 26-30 (*n* = 1) | | ✔ | | | | ✔ | | | |
| 31-40 (*n* = 3) | | ✔ | ✔ | | ✔ | | | ✔ | ✔ |
| 41-50 (*n* = 3) | | ✔ | ✔ | ✔ | | | ✔ | | ✔ |
| 61-70 (*n* = 2) | ✔ | ✔ | ✔ | | ✔ | | ✔ | | |

**Table 4.6.4**

*Codes for students on different subject disciplines for open-text comments*

| | Distraction | Useful | Training | Constantly changing | Makes life harder | Incompatibility | Reliability | Overwhelming | Apprehension |
|---|---|---|---|---|---|---|---|---|---|
| The sciences (*n* = 2) | ✔ | ✔ | | | ✔ | | | | |
| Social sciences (*n* = 5) | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | | | ✔ |
| Arts and humanities (*n* = 3) | ✔ | | ✔ | | ✔ | | ✔ | ✔ | ✔ |
| Engineering (*n* = 1) | | | | | | | ✔ | | |

**Table 4.6.5**

*Codes for students on full-time or part-time courses for open-text comments*

| | Distraction | Useful | Training | Constantly changing | Makes life harder | Incompatibility | Reliability | Overwhelming | Apprehension |
|---|---|---|---|---|---|---|---|---|---|
| Full time (*n* = 6) | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ | ✔ |
| Part time (*n* = 5) | ✔ | ✔ | ✔ | | ✔ | | ✔ | | ✔ |

**Table 4.6.6**

*Themes for different ages of student for open-text comments*

| | Utility | Knowledge | Confidence |
|---|---|---|---|
| 18-21 (*n* = 2) | ✔ | | ✔ |
| 26-30 (*n* = 1) | ✔ | | |
| 31-40 (*n* = 3) | ✔ | ✔ | ✔ |
| 41-50 (*n* = 3) | ✔ | ✔ | ✔ |
| 61-70 (*n* = 2) | ✔ | ✔ | |

**Table 4.6.7**

*Themes for students on different subject disciplines for open-text comments*

| | Utility | Knowledge | Confidence |
|---|---|---|---|
| The sciences (*n* = 2) | ✔ | | |
| Social sciences (*n* = 5) | ✔ | ✔ | ✔ |
| Arts and humanities (*n* = 3) | ✔ | ✔ | ✔ |
| Engineering (*n* = 1) | ✔ | | |

**Table 4.6.8**

*Themes for students on full-time or part-time courses for open-text comments*

| | Utility | Knowledge | Confidence |
|---|---|---|---|
| Full time (*n* = 6) | ✔ | ✔ | ✔ |
| Part time (*n* = 5) | ✔ | ✔ | ✔ |

Participants from all age groups felt that technology was useful, but interestingly these students were all from the sciences and social sciences. They gave a variety of reasons for finding technology useful, from organising their studies and materials, saving time on certain tasks, and the ability to access more material. However, one of the arts and humanities students said:

> I also feel like technology prevents people from reading and researching physically rather than just surfing the web. (Participant 1)

I interpret this student as saying that engaging with physical media such as books is preferable to web-based reading. This could begin to explain why the arts students feel technology is less useful for their studies than the science and social science students. The arts and humanities are more focussed on texts, and as such, it is possible that technology is less a part of their learning activities.

Students of all ages mentioned that technology can make their tasks harder, by overcomplicating a task, having it take longer than pen-and-paper solutions, or being stressful. This is also linked to reliability – several students, again across several demographics, mentioned that technology can be unreliable, particularly the Internet. These are two negative aspects of technology where the utility is reduced.

Both students from the 18-21 age group, and one student from the 61-70 group, felt that technology was a distraction. The students were from across various disciplines and modes of study. The older student recognised that they had found technology, particularly social media, useful for learning purposes, but also felt that "one has to set limits" in order to prevent it becoming a "terrible time-waster" (Participant 10). Technology as a distraction reduces the overall utility of technology for learning. However, it is worth noting that technology is often utilised specifically to distract in one's personal life, or avoid boring or difficult educational tasks (Aagaard, 2015).

Participants from the three older groups in the study all made comments on how they either had or would have wanted training and support for using technology. In two of these groups, the students were also apprehensive about or overwhelmed by technology. One student, aged 31-40 from the arts and humanities, wrote:

> New technology is hard to learn and I need a lot of practices (or occasions) to acquire the skill to use it. I attended several one-day workshops on new softwares, but I could learn none of them. I forgot how to use them soon after the workshops. (Participant 5)

Technology is constantly evolving, and it seems that Participant 5 is finding it particularly difficult to keep up. Participant 7 mentioned that new technologies are often expensive, and that if you don't keep up, "you are left behind in this world". Overall, it is the older students who made comments falling under the knowledge theme, suggesting that they are more concerned about their perceived technology knowledge levels than younger students.

For the theme of confidence, the arts and humanities students were most likely to express feelings of apprehension towards technology, and feelings of being overwhelmed. There was no particular trend between the age groups.

Overall, it is worth noting that the arts and humanities students seem more likely to express feelings about the negative themes surrounding technology than the other disciplines. As I mentioned above, this may be due to a different focus within their degree pathways, and therefore, arguably, less technological affinity within the historical cultures of these disciplines.

## 4.7 Qualitative Interview Analysis

A total of 11 participants took part in the interviews. Tables 4.7.1 to 4.7.4 show the demographics of the participants.

**Table 4.7.1**
*Frequencies and percentages of mature (26+) and non-mature (under 26) students in the sample*

| | Frequency | Percent |
|---|---|---|
| Non-mature | 5 | 45.5 |
| Mature | 6 | 54.5 |
| Total | 11 | 100.0 |

**Table 4.7.2**
*Frequencies and percentages of students of the different age ranges in the sample*

| Age bracket | Frequency | Percent |
|---|---|---|
| 0-17 | 0 | 0.0 |
| 18-21 | 3 | 27.3 |
| 22-25 | 2 | 18.2 |
| 26-30 | 1 | 9.1 |
| 31-40 | 0 | 0.0 |
| 41-50 | 4 | 36.4 |
| 51-60 | 0 | 0.0 |
| 61-70 | 1 | 9.1 |
| 71+ | 0 | 0.0 |
| Total | 11 | 100.0 |

**Table 4.7.3**

*Frequencies and percentages of full time and part time students in the sample*

| | Frequency | Percent |
|---|---|---|
| Full time | 10 | 90.9 |
| Part time | 1 | 9.1 |
| Total | 11 | 100.0 |

**Table 4.7.4**

*Frequencies and percentages of course disciplines in the sample*

| | Frequency | Percent |
|---|---|---|
| The sciences | 0 | 0.0 |
| Social science | 5 | 45.5 |
| Arts and humanities | 4 | 36.4 |
| Engineering | 2 | 18.2 |
| Medicine, dentistry and health | 0 | 0.0 |
| Total | 11 | 100.0 |

Table 4.7.5 shows the profiles of the participants. Although not all age groups or disciplines are represented, the participants are clearly diverse, from a range of genders and backgrounds in addition to the demographics formally collected. I have also included a column named 'Taught by me', as several of the participants were known to me in my capacity as a lecturer on the foundation year course at my institution (designed specifically for mature students entering higher education). I felt it was important to include this information before the analysis, as my personal interactions with the students may have had an effect on their responses or my understanding of them (Tong et al., 2007). All of the participants whom I had taught were part of a large group of approximately 80 taught students. They were students who regularly attended, and were engaged in class. I would class my relationship with these students as good, but not close. All interaction with them on my course pertained to the topic of the class, and did not overflow into a personal capacity. The interviews with all participants took place after the foundation course had ended, and also after any exams and assessments had been completed, so this would not have affected their participation in my study. I therefore have no reason to believe these students would be anything other than truthful in their responses, although perhaps they might have been inclined to be more open with me than the students I did not teach. This is not necessarily a bad thing, but something to be aware of. However, I did not notice any particular differences in interview openness between the students I taught and the students I did not.

**Table 4.7.5**
*Interview participant profiles*

| Pseudonym | Mature? | Age group | Discipline | Mode of study | Taught by me |
|---|---|---|---|---|---|
| Bill | No | 18-21 | Arts and humanities | Full time | No |
| Daniel | No | 18-21 | Engineering | Full time | No |
| Emma | No | 18-21 | Arts and humanities | Full time | No |
| Harris | No | 22-25 | Social sciences | Full time | No |
| Chun | No | 22-25 | Social sciences | Full time | No |
| Sophia | Yes | 26-30 | Social sciences | Full time | No |
| Julie | Yes | 41-50 | Arts and humanities | Full time | Yes |
| Anne | Yes | 41-50 | Social sciences | Full time | Yes |
| Aylen | Yes | 41-50 | Engineering | Part time | No |
| Gwen | Yes | 41-50 | Social sciences | Full time | Yes |
| Felix | Yes | 61-70 | Arts and humanities | Full time | Yes |

After reading through the codes and the extracts within, 14 broad areas were identified, as suggested in step three in Braun and Clarke's (2006) thematic analysis (the processes addressing steps one and two are detailed in the Methods chapter of this thesis). However, two of these were simply 'definitions' which I did not count as themes, and one was whether the attitude expressed was positive or negative, which is not a theme in itself. I also did not count the mention of specific technologies as a theme. Therefore overall, 10 themes were generated from the qualitative interview data.

The themes were then reviewed (as per step four) in a two-step process: the first of which is to review themes at the coded extract level; and the second of which is to consider the themes in relation to the whole dataset (Braun & Clarke, 2006). I reviewed all of the coded extracts for each theme, and assessed whether they were internally and externally homogenous (Patton, 1990 as cited in Trahan & Stewart, 2013). Internal homogeneity asks whether themes cohere together, or required splitting. External homogeneity asks whether themes are distinct from each other, or require merging with other themes (Patton, 1990; Trahan & Stewart, 2013). I saw that several of the themes I had initially identified were actually subthemes of a larger theme, resulting in five themes overall, of which one had six subthemes.

Step five is to define, refine, and name the themes. I went through the extracts and codes for each theme, and ensured they fitted. I also began considering how each theme fed into my participants' overall data story. The development of themes took a substantial amount of time, with much reading, re-reading, and iterative coding and grouping. This close scrutinisation improves the credibility of the results (Nowell et al., 2017). Fagerhaugh (1986) suggests themes and their names should be gerunds to give the flavour of the underlying processes described by the data, however this is not necessarily appropriate when the research itself is not focussed on social processes, as my study is not. Nowell et al. (2017) recommend using participant quotes as the theme names in order to keep the flavour of the theme from the participants' points of view. However, this relies on participants accurately summarising their own *and* others' viewpoints in a soundbite. While the theme name might sound catchy and seem like a snapshot of the participants' intent, it is unlikely to fully encapsulate the range of responses from multiple participants. I therefore chose my own summary words and phrases rather than borrowing from participants.

**Table 4.7.6**

*Themes generated from the coded interview data*

| Code | Sub themes | Theme |
|---|---|---|
| Addiction<br>Casual mention of non-normal tech<br>Exposure<br>Knowing lots of tech<br>Familiarity | | Familiarity |
| How children or younger people use tech<br>How older people use tech | | Age |
| Changes over time<br>Depth of knowledge<br>Programming and behind the scenes<br>Technology learning | | Knowledge |
| Communication<br>Feedback<br>Group learning<br>How you look to others<br>Learning from others<br>Lecturers' use<br>Replaces face to face<br>Support | | Interaction |
| Confidence<br>Easy<br>Frustration<br>Learning on own<br>Not scared<br>Understanding<br>Worry | Confidence | Motivation |
| Communication<br>Disability<br>Discipline or subject<br>Feedback<br>Fit for purpose<br>Job or workplace<br>Lecturers' use<br>Makes life easier<br>Necessity | Purpose | |

| | |
|---|---|
| Practical use<br>Replaces face to face<br>Usefulness<br>Verification | |
| Convenient<br>Flexibility<br>Learning style<br>Speed | Convenience |
| Access<br>Avoid<br>Cost<br>Cybercrime<br>Distraction<br>Doing the right thing<br>Fear<br>Fragility<br>Gender<br>Incompatibility<br>Reliability or breaks<br>Support<br>Tired of using tech<br>Too pervasive<br>Trust | Barriers |
| Challenging self<br>Desire to learn<br>Enjoy technology<br>Enjoyment changed<br>Exciting<br>Interest<br>Novelty | Enjoyment |
| Complexity<br>Customisable<br>Formatting and layout<br>Interactivity<br>Intuitive<br>Keeping updated<br>Overload<br>Quality<br>Standardisation | Design |

The themes and subthemes are shown in Table 4.7.6, with the codes making up each theme shown. The themes of 'Confidence', 'Purpose', 'Convenience', 'Barriers', and 'Enjoyment' are part of the larger theme of 'Motivation', in this case, the motivation to use technology generally. However, if I were to add the theme of 'Design' to these, my larger theme would become more of 'Motivation to use a particular technology'. This is an interesting distinction, and worth thinking about further. For initial analysis purposes, I have used this wider 'Motivation to use a particular technology', but I will also discuss this further when considering this theme.

Table 4.7.7 shows how many times each code was mentioned, and the mean percentage coverage. This was calculated by averaging the percentage of the interviews that was covered by each code. The table also includes the percentage of students who mentioned each code. The percentage coverage is particularly useful, since frequency of mentions can be one long mention, or a few smaller mentions, interspersed with mentions of other codes, which would result in a higher frequency. Percentage coverage, calculated from NVivo, mitigates this effect. It is still interesting to see how many different times a code came up in conversation, however.

**Table 4.7.7**
*Number of mentions of each code, percentage coverage for each code, and percentage of students who mentioned each code for the interview data*

| Code | Number of mentions | Mean percentage coverage | Percentage of students who mentioned it |
|---|---|---|---|
| Addiction | 7 | 4.4 | 36.4 |
| Casual mention of non-normal tech | 11 | 6.1 | 36.4 |
| Exposure | 22 | 6.9 | 90.9 |
| Knowing lots of tech | 67 | 18.2 | 90.9 |
| Familiarity | 9 | 3.9 | 63.6 |
| How children or younger people use tech | 33 | 7.3 | 100.0 |
| How older people use tech | 20 | 5.7 | 100.0 |
| Changes over time | 24 | 6.6 | 100.0 |
| Depth of knowledge | 9 | 4.4 | 45.5 |
| Programming and behind the scenes | 19 | 4.8 | 81.8 |
| Technology learning | 15 | 6.6 | 72.7 |
| Communication | 28 | 10.1 | 81.8 |
| Feedback | 5 | 5.5 | 18.2 |
| Group learning | 5 | 2.7 | 36.4 |
| How you look to others | 8 | 3.6 | 54.5 |
| Learning from others | 28 | 9.2 | 90.9 |
| Lecturers' use | 19 | 15.9 | 36.4 |
| Replaces face to face | 14 | 10.5 | 27.3 |
| Support | 42 | 13.9 | 100.0 |
| Confidence | 30 | 26.4 | 100.0 |
| Easy | 28 | 9.2 | 72.7 |
| Frustration | 19 | 10.0 | 54.5 |
| Learning on own | 17 | 4.9 | 90.9 |
| Not scared | 5 | 2.7 | 18.2 |
| Understanding | 12 | 7.3 | 45.5 |

| | | | |
|---|---|---|---|
| Worry | 16 | 5.9 | 72.7 |
| Communication | 28 | 10.1 | 81.8 |
| Disability | 1 | 3.3 | 9.1 |
| Discipline or subject | 18 | 6.9 | 72.7 |
| Feedback | 5 | 5.5 | 18.2 |
| Fit for purpose | 25 | 9.7 | 81.8 |
| Job or workplace | 21 | 8.9 | 54.5 |
| Lecturers' use | 19 | 15.9 | 36.4 |
| Makes life easier | 20 | 6.1 | 63.6 |
| Necessity | 16 | 9.8 | 45.5 |
| Practical use | 26 | 7.4 | 81.8 |
| Replaces face to face | 14 | 10.5 | 27.3 |
| Usefulness | 55 | 15.8 | 90.9 |
| Verification | 2 | 2.6 | 9.1 |
| Convenient | 16 | 5.6 | 63.6 |
| Flexibility | 3 | 3.9 | 27.3 |
| Learning style | 11 | 3.8 | 54.5 |
| Speed | 24 | 6.8 | 81.8 |
| Access | 25 | 7.4 | 100.0 |
| Avoid | 9 | 3.0 | 54.5 |
| Cost | 2 | 3.1 | 18.2 |
| Cybercrime | 3 | 3.6 | 27.3 |
| Distraction | 6 | 3.0 | 45.5 |
| Doing the right thing | 10 | 4.9 | 54.5 |
| Fear | 3 | 2.5 | 18.2 |
| Fragility | 3 | 3.7 | 18.2 |
| Gender | 3 | 2.8 | 27.3 |
| Incompatibility | 3 | 4.4 | 18.2 |
| Reliability or breaks | 19 | 6.4 | 63.6 |
| Support | 42 | 13.9 | 100.0 |
| Tired of using tech | 2 | 2.5 | 18.2 |
| Too pervasive | 4 | 3.2 | 27.3 |
| Trust | 8 | 4.6 | 45.5 |
| Challenging self | 9 | 3.2 | 54.5 |
| Desire to learn | 22 | 6.4 | 100.0 |
| Enjoy technology | 35 | 26.4 | 100.0 |
| Enjoyment changed | 5 | 2.3 | 45.5 |
| Exciting | 2 | 7.5 | 9.1 |
| Interest | 17 | 5.7 | 72.7 |
| Novelty | 8 | 6.0 | 45.5 |
| Complexity | 14 | 5.3 | 72.7 |
| Customisable | 2 | 3.0 | 9.1 |
| Formatting and layout | 14 | 9.2 | 54.5 |
| Interactivity | 10 | 6.5 | 36.4 |
| Intuitive | 8 | 10.1 | 27.3 |

| | | | |
|---|---|---|---|
| Keeping updated | 5 | 3.5 | 36.4 |
| Overload | 5 | 3.2 | 27.3 |
| Quality | 6 | 10.2 | 27.3 |
| Standardisation | 5 | 3.1 | 36.4 |

Tables 4.7.8, 4.7.9 and 4.7.10 show how often each demographic group spoke about each of the themes. The median was used to account for non-normality of the data.

**Table 4.7.8**
*Median number of times each theme (and subtheme) was mentioned by different ages of student*

| | | | | | Motivation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Familiarity | Age | Knowledge | Interaction | Confidence | Purpose | Convenience | Barriers | Enjoyment | Design |
| 18-21 (*n* = 3) | 12.0 | 2.0 | 4.0 | 6.0 | 7.0 | 13.0 | 6.0 | 9.0 | 5.0 | 5.0 |
| 22-25 (*n* = 2) | 5.5 | 3.5 | 5.5 | 12.0 | 4.0 | 14.5 | 3.5 | 8.0 | 7.0 | 4.5 |
| 26-30 (*n* = 1) | 7.0 | 3.0 | 5.0 | 12.0 | 5.0 | 20.0 | 4.0 | 6.0 | 5.0 | 2.0 |
| 41-50 (*n* = 4) | 9.5 | 6.0 | 4.0 | 9.0 | 9.5 | 14.5 | 4.5 | 13.0 | 7.5 | 5.0 |
| 61-70 (*n* = 1) | 6.0 | 8.0 | 8.0 | 7.0 | 4.0 | 4.0 | 3.0 | 8.0 | 6.0 | 0.0 |

Before analysing the themes, I will discuss the definition-style questions I asked participants as openers to certain sections of the interview. For the first interview question, I asked participants to explain to me what ‘technology-enhanced learning’ meant to them. Later in the interview, I asked them to define ‘technology knowledge’. These definitions will be used to inform my later discussion of themes.

**Table 4.7.9**
*Median number of times each theme (and subtheme) was mentioned by students on different subject disciplines*

| | | | | | Motivation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Familiarity | Age | Knowledge | Interaction | Confidence | Purpose | Convenience | Barriers | Enjoyment | Design |
| Social sciences (n = 5) | 7.0 | 4.0 | 5.0 | 9.0 | 5.0 | 12.0 | 4.0 | 8.0 | 7.0 | 4.0 |
| Arts and humanities (*n* = 4) | 8.5 | 6.0 | 5.0 | 6.5 | 4.0 | 9.5 | 3.5 | 8.0 | 6.0 | 3.0 |
| Engineering (*n* = 2) | 12.5 | 4.0 | 4.0 | 15.5 | 15.0 | 24.5 | 5.5 | 17.5 | 7.5 | 10.0 |

**Table 4.7.10**
*Median number of times each theme (and subtheme) was mentioned by students on full-time or part-time courses*

| | | | | | Motivation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Familiarity | Age | Knowledge | Interaction | Confidence | Purpose | Convenience | Barriers | Enjoyment | Design |
| Full time (n = 10) | 8.0 | 4.0 | 4.5 | 8.0 | 5.0 | 12.5 | 4.0 | 8.0 | 6.0 | 4.5 |
| Part time (*n* = 1) | 10.0 | 6.0 | 4.0 | 23.0 | 23.0 | 35.0 | 5.0 | 22.0 | 12.0 | 10.0 |

### 4.7.1 The Definition of Technology-Enhanced Learning

All participants gave examples of specific technologies when asked what 'technology-enhanced learning' (TEL) meant to them. This is interesting, and reflects the confusion in the literature over what TEL actually is, the technology or the process. The technologies mentioned included computers, software generally, virtual learning environments (VLEs), videos, library catalogues, quizzes and voting systems, lecture capture, online marking, and specific websites. Both hardware and software was mentioned, and Table 4.7.11 shows which students mentioned which, and how many times. Participants also mentioned technology that would help with learning disabilities such as dyslexia, or just simply different learning styles. Several students mentioned that these technologies were already in place for them to use, which is encouraging for our educational system.

Daniel felt that TEL provides a "channel of communication" between teachers and learners (Daniel), which is a good thing. Aylen also addressed the lecturer's role, saying that TEL is using "digital" resources to do anything beyond "just standing there and giving a lecture" (Aylen). This idea of improving the actual learning, not just using resources that are technologies, was mentioned by five of the participants. As Harris puts it,

> I don't see how [all these things] really enhance learning. It sounds like, "Yeah, we use technology in our teaching", but is it really effective when it comes to enhancing learning? (Harris)

This is an important point, and one that I strongly support. The use of technology is being pushed by universities through their Learning and Teaching Strategies (as discussed in section 2.5 in the Literature Review), but lecturers and tutors need to think carefully about how to use technology to improve learning, whether through teaching lessons or assessing knowledge gain, rather than just including technology for the sake of it.

**Table 4.7.11**

*Number of times hardware or software was mentioned as a type of TEL*

| Pseudonym | Age group | Hardware | Software |
|---|---|---|---|
| Bill | 18-21 | 0 | 0 |
| Daniel | 18-21 | 0 | 2 |
| Emma | 18-21 | 0 | 3 |
| Harris | 22-25 | 1 | 2 |
| Chun | 22-25 | 0 | 2 |
| Sophia | 26-30 | 0 | 2 |
| Julie | 41-50 | 3 | 1 |
| Anne | 41-50 | 1 | 1 |
| Aylen | 41-50 | 0 | 9 |
| Gwen | 41-50 | 1 | 2 |
| Felix | 61-70 | 0 | 1 |

### 4.7.2 The Definition of Technology Knowledge

Participants all said that there are different levels of knowledge, and some made an attempt to place themselves on the scale. For example, Felix said technology knowledge is "all of the skills that I don't have" (Felix) while Anne claimed to have a "baseline level […] but there's a whole zillion levels" (Anne).

Overall, three distinct aspects of technology knowledge were identified by participants. The first aspect (type I) is knowing how to use a range of technologies on a practical basis, how confident you are with that, and how many technologies you are able to use. As Julie puts it, "We don't think, we just use" (Julie). The second aspect (type II) is understanding, building, and being able to fix problems with technology hardware. The third (type III) is programming and software development, which participants labelled as "professional knowledge" (Chun, Sophia).

### 4.7.3 Familiarity

Most participants expressed strong opinions that familiarity with technology was an important part of their confidence and attitude towards it. Some participants thought about this in terms of technology generally, such as Emma who says, "I think I'm pretty confident cause I, yeah, grown up with it, and it's kind of second nature to me in a way", where early exposure to technology enables confidence to use technology. Others mentioned that using a wide range of technologies allowed them to learn a universal language that exists across most modern technology. As Daniel puts it:

> Daniel: A lot of things are designed so this button is shaped like it's supposed to be doing that, with websites people are using similar themes, even with smaller mobile versions I just instantly understand that three horizontal lines is a menu and that like a round circle with a rectangle beneath it is an account. […] I see a piece of technology and I just feel as if I know how to use it. […]
>
> Rachel: So you think that it's kind of this consistency across all the platforms, that there is this shared language?
>
> Daniel: Yeah, yeah. And it's the language that I can speak. So, even if I find a new word or phrase in the language, I'll still understand what it means.

Others thought about the familiarity of technology in terms of specific technologies that they knew how to use because they were used to them. This was true for both non-mature and mature students. Chun, a younger student, says, "I'm confident to use what I can use, or what I know, for new things, I need to learn it" (Chun). I interpret this to mean that Chun is only confident with familiar technologies. Whereas Felix, the oldest participant, says he's most confident using "a laptop. Second only to PC, which is effectively the same. Probably because I'm used to them, rather than anything else" (Felix). Chun's and Felix's respective viewpoints can be interpreted as "general familiarity" and "familiarity in terms of a specific technology". These are obviously not mutually exclusive, so it must be borne in mind that there are multiple levels of familiarity.

Some participants felt that familiarity with technology increased their enjoyment using them.

> Rachel: Do you generally enjoy using technology for learning?
>
> Bill: [pause] Yes but I think mostly just because that's the main thing I'm used to.

Some of the participants discussed their feelings about how age and generation affect one's familiarity with technology. Most thought that younger students have an advantage in that it has been a part of their lives while growing up. Daniel, a non-mature student, says, "I just feel as if our generation is just surrounded by technology enough to be able to use it for anything" (Daniel). Likewise, Felix says:

> I suppose I'm scared of it. Because I've not grown up with it. Whereas younger people have grown up with it from a very early age and they're confident. That's the difference. (Felix)

As shown by these excerpts, being more familiar with technology can make one more confident with it. On the other hand, if students used technologies they were unfamiliar with, they were liable to have lower confidence, or even experience anxiety. This was particularly true for the younger participants I interviewed:

> Definitely unfamiliar things I have a slight unconfidence in, and "I don't know what I'm doing" [laugh] but it's a matter of just getting used to it really. (Bill)
>
> I'm used to using Windows, so I think if someone were to like put a Mac in front of me, I wouldn't really know what to do, and I think it can be a bit alienating to see something like that. (Emma)

Others viewed familiarity as a bad thing, an addiction.

> Rachel: So technology is necessary?
>
> Harris: Yes, it is necessary, but like I say, technology brings convenience. So because of that convenience, people tend to cling to it. And enjoy the utmost of the technology and try to make full use of it to the extent that addictive behaviour happens and that's also when his or her life is going to collapse. (Harris)

It is possible that this opinion is due to the media demonising heavy technology use (e.g. Manjoo, 2018). Some students make an active attempt not to succumb to the addiction.

> If you use [technologies] all the time then they become sort of, not indispensible cause I don't want to be that kind of person where I need it, but it definitely becomes a big part of like your day-to-day. (Emma)

The reasons why people feel addicted to technology are many and this has been studied elsewhere (e.g. Acier & Kern, 2011; Hawi & Samaha, 2016), but Sophia suggests that:

> People get addicted to it, to the fact that many people put likes. I guess it's a feeling of rewarding? And it does, it gives me that reward as well when I get a lot of likes. (Sophia)

As a proxy for familiarity, I assumed that if a student mentioned a 'non-normal' technology, i.e., a piece of technology that isn't widespread or common knowledge, they could be viewed as being 'very familiar' with technology. Widespread technologies that are common include mobile phones, computers, laptops, YouTube, etc. However, some non-normal technologies mentioned included NAS servers, Doodlepoll, specific computer models such as the Sinclair ZX81 (as opposed to "a Mac"), or programming languages like R. Out of the 11 students who participated, four (36%) students mentioned these non-normal technologies. These students were Aylen, Daniel, Julie, and Sophia, of whom three (75%) were mature. Aylen, Daniel and Julie all stated they had high confidences with technology compared to the other participants. Sophia stated her confidence was fairly low, but this makes sense, since her comment about the 'non-normal' technology she mentioned was her saying it was "out of my league".

### 4.7.4 Age

Tables 4.7.12 to 4.7.14 show the results of a number of closed questions about how participants rated how knowledgeable they felt about technology against other groups of people (same age, younger, older, friends, family). Generally, participants seemed to interpret me asking about people the "same age" as their friends, and people "older" than them as family, based on how they referred to friends and family on the age-based questions. There were some exceptions, particularly among the mature students who often had mixed-age friendship groups. After each closed question comparison, I asked students to justify their answer.

There was no apparent relationship across the age ranges when comparing themselves to people the same age. Most participants felt they had similar knowledge levels to people the same age (Table 4.7.12), and this was even more the case when specifically asked to compare themselves to friends (Table 4.7.13). This may suggest that perceived knowledge level is a function of age – perhaps what was taught in school in a particular decade, or how in-work training occurs throughout the years. Perhaps students tend to group in friendship groups of similar perceived knowledge level.

**Table 4.7.12**
*Different age groups and knowledge level compared to people same age as them*

| | Knowledge level | | |
|---|---|---|---|
| | I know less | I know the same | I know more |
| 18-21 | 0 | 1 | 2 |
| 22-25 | 1 | 1 | 0 |
| 26-30 | 1 | 0 | 0 |
| 41-50 | 0 | 3 | 1 |
| 61-70 | 0 | 1 | 0 |
| Total | 2 | 6 | 3 |

**Table 4.7.13**
*Different age groups and knowledge level compared to friends*

| | Knowledge level | | |
|---|---|---|---|
| | I know less | I know the same | I know more |
| 18-21 | 1 | 1 | 1 |
| 22-25 | 0 | 1 | 1 |
| 26-30 | 0 | 1 | 0 |
| 41-50 | 0 | 4 | 0 |
| 61-70 | 0 | 1 | 0 |
| Total | 1 | 8 | 2 |

**Table 4.7.14**
*Different age groups and knowledge level compared to people younger than them*

| | Knowledge level | | |
|---|---|---|---|
| | I know less | I know the same | I know more |
| 18-21 | 1 | 0 | 2 |
| 22-25 | 1 | 0 | 1 |
| 26-30 | 1 | 0 | 0 |
| 41-50 | 2 | 1 | 1 |
| 61-70 | 1 | 0 | 0 |
| Total | 6 | 1 | 4 |

Only about half the students felt that they knew less than people younger than them (Table 4.7.14). However, those that did feel this way usually felt it strongly. Felix felt that he was "massively disadvantaged" compared to his younger classmates, and Gwen felt "very unknowledgeable compared to […] well, the kids and things". Sophia suggests this is because younger people are "more active, more persistent users of technology", which ties in to the familiarity idea.

Some students also discussed how they often sought help from younger classmates or family members:

> If I have a problem I go to one of my classmates and say, "Look, I've got a problem". […] They're all young people that I'm associating with, and they know it without giving it a second thought. (Felix)

The idea that children seemed hugely capable was common among some of the older students, with some of the older students saying they would seek help with technology from a child.

> Rachel: How knowledgeable do you feel?
>
> Gwen: Not particularly. You know, compared with kids who just seem to be able to just do anything, do everything without really thinking about it.

In contrast, over a third of the students felt they knew more than younger people. The reasons given include references to all three of the types of technology knowledge:

For type I (Knowing how to use a wide range of technologies):

> Just for the sake of age, just being older, I would have been around technology a lot longer, and used more technologies as an adult. (Daniel)

For type II (Understanding, building, fixing):

> I think there's two things. I think there's using it, and understanding it. I think I understand it but I don't use it whereas younger people use it, but don't understand it. (Aylen)

For type III (Programming and software development):

> Those spoiled kids. [laugh] I would say, I'm quite confident in having more knowledge than them, because like I say, um, programming is a fundamental feature of all advanced technology that we have right now. (Harris)

Since the question was about knowledge, it makes sense that it would tie in explicitly with the three types of knowledge that participants developed.

One participant expressed a dichotomous view of how younger students engage with technology. Anne states that:

> Even like teenagers, would be hugely more knowledgeable [than me], because that's their gift, they love computer programming, they love technology. (Anne)

But later, she says:

> One of my friends actually has set up a science thing and she's linking that in with computer technology and the programming side of it, cause I say the kids, they do a lot of playing but they don't actually know what goes on inside the computer. (Anne)

This is really interesting, since in my experience people often hold dichotomous opinions such as these. There is often a popular, 'stereotypical' opinion that people hold without critical thought, but when you question them more deeply, it turns out there are a lot of exceptions to the stereotype, and that they actually have a different opinion. This is particularly applicable in a constructivist worldview, where an opinion can be assimilated without cognitive dissonance and the need for accommodation. Anne's stereotypical surface opinion seems to be that all young people have high type III technology knowledge such as programming, but her deeper opinion is that kids don't understand what they are doing, and are therefore have low type III knowledge. This second opinion seems to be more linked to everyday reality – Anne is talking about an actual example from her life – and thus seems more thought-through. The first opinion, however, is not linked with real experience, and almost seems a throwaway comment. Although I tried to delve deeply into students' reasons for their opinions, I believe these dichotomous opinions are likely to be present for a lot of participants in any interview asking about attitudes and opinions. This seems unavoidable, but also may have implications for the research. However, since this dichotomy is perfectly valid to exist in a constructivist paradigm, I accept that students may hold these contradictory views, that I may uncover them, and that I should accept that both views are actual opinions the participant holds.

Aylen mentions a "generational gap" that she perceives between how she and her children use technology:

> And you can be sat there in the evening, and I'll be watching a television, they'll be on their phones and as soon as I change the channel, they'll go, "Oh I was watching that!" and I'll go, "How can you be watching it when you're doing this on your phone all the time?" "Oh, yeah, well, I'm multitasking." I think there's definitely a generational gap there that I struggle with. Younger people want to multitask all the time. (Aylen)

It is common that younger people are attributed with the ability to multitask, however Kirschner and de Bruyckere (2017) say this is a myth. Instead younger people are just rapidly task switching, which has negative effects on their ability to engage with any task. However, there still very much exists a perception that younger people can multitask, and that they are "the digital generation" (Aylen), and this perception exists even in the non-mature students. Bill says, "[younger people], they were born into it", meaning born into a world where technology is a part of our lives.

**Table 4.7.15**

*Different age groups and knowledge level compared to people older than them*

| | Knowledge level | | |
|---|---|---|---|
| | I know less | I know the same | I know more |
| 18-21 | 0 | 1 | 2 |
| 22-25 | 0 | 0 | 2 |
| 26-30 | 0 | 1 | 0 |
| 41-50 | 0 | 0 | 4 |
| 61-70 | 0 | 0 | 1 |
| Total | 0 | 2 | 9 |

There is a clear trend that the participants generally felt that they were more knowledgeable about technology than people older than them (Table 4.7.15). No one felt that they knew less, despite the participants themselves sometimes thinking they knew more than younger people; however, this is an opinion that the younger people do not share.

**Table 4.7.16**

*Different age groups and knowledge level compared to family*

| | Knowledge level | | |
|---|---|---|---|
| | I know less | I know the same | I know more |
| 18-21 | 0 | 1 | 2 |
| 22-25 | 0 | 1 | 1 |
| 26-30 | 0 | 0 | 1 |
| 41-50 | 2 | 0 | 1 |
| 61-70 | 1 | 0 | 0 |
| Total | 3 | 2 | 5 |

There seems to be a trend that older people feel that they know less than their family, whereas younger people generally feel they know more, as shown in Table 4.7.16. This could be due to an interpretation of what “family” means. I did not state in the interview questions which family I was asking about. “Family” is a very broad construct, consisting of anything from grandparents to grandchildren, siblings to cousins, and this was reflected in the answers that participants gave. The older participants often talked about their children and spouses as their family, whereas the younger participants usually talked about their siblings and parents. This matches well with the previous results about how knowledgeable students feel compared to younger and older groups of people.

Bill says:

> I think they've also had to adapt to the change in technology in the workforce, or like offices or stuff like that, so. But then at the same time, I think they're also a lot slower at kind of understanding in comparison to youth and people my age. (Bill)

This opinion that older people can be more adaptive than younger people is interesting, and acts almost as an antithesis to the stereotype that young people automatically 'know' (i.e., haven't actively *learned*) about technology, whereas older people have learned or adapted to technology. This may also suggest a difference in whether they learned about technology in a formal or informal context, where informal learning may happen invisibly. As a result, we don't necessarily see a continuum between young people knowing technology and older people not knowing technology, but more a willingness and ability to learn. Several participants back up this point, by giving specific examples of an older person in their life who is great with technology. Chun says:

> My parents are not good at technologies, but the problem is my grandfather good at it. Yeah. Because he was in engineering, it depends on his job. So he is willing to study, to learn new technologies, it makes him excited. (Chun)

She links her grandfather's technological prowess explicitly with his job, that it was something that he had to learn and thus developed a passion for. Julie, an older student, says, "If I wanted to use that program, then I would have to learn", and this is probably true of adults in work and life.

### 4.7.5 Knowledge

It was surprising to me that so few participants had any qualifications in technology, computing, or ICT, since in my secondary school, taking an Information Technology short-course GCSE was compulsory, and I assumed this was the case for every student my age. However, as seen in Table 4.7.17, only four participants had any ICT qualification whatsoever, and Table 4.7.18 shows that only one of these was at GCSE-level. Table 4.7.19 shows how long ago the qualifications were gained. It seemed to be that it was mainly the 41-50 age group who had qualifications, which were gained while working, in order to be used for their job. These were also done over 10 years ago, which suggests a change in technology in the workplace, requiring the workforce to learn new skills.

**Table 4.7.17**
*Different age groups and if they have any ICT, computing, technology qualifications*

| | Qualification | |
|---|---|---|
| | Yes | No |
| 18-21 | 1 | 2 |
| 22-25 | 0 | 2 |
| 26-30 | 0 | 1 |
| 41-50 | 3 | 1 |
| 61-70 | 0 | 1 |
| Total | 4 | 7 |

**Table 4.7.18**
*Different age groups and type of qualification*

| | Type of qualification | | | |
|---|---|---|---|---|
| | None | Not specified | Vocational – courses done through work, etc | GCSE, BTEC, O-level, etc |
| 18-21 | 2 | 0 | 0 | 1 |
| 22-25 | 2 | 0 | 0 | 0 |
| 26-30 | 1 | 0 | 0 | 0 |
| 41-50 | 1 | 1 | 2 | 0 |
| 61-70 | 1 | 0 | 0 | 0 |
| Total | 7 | 1 | 2 | 1 |

**Table 4.7.19**
*Different age groups and year of qualification*

| | Year of qualification | | | | |
|---|---|---|---|---|---|
| | None | Less than 3 years ago | 3-5 years ago | 6-10 years ago | More than 10 years ago |
| 18-21 | 2 | 0 | 1 | 0 | 0 |
| 22-25 | 2 | 0 | 0 | 0 | 0 |
| 26-30 | 1 | 0 | 0 | 0 | 0 |
| 41-50 | 1 | 0 | 0 | 0 | 3 |
| 61-70 | 1 | 0 | 0 | 0 | 0 |
| Total | 7 | 0 | 0 | 0 | 3 |

In addition to the definition of technology knowledge discussed in section 4.7.2 above, several other topics were discussed.

Participants often commented on their “depth of knowledge”. They often viewed this as relating to the technology knowledge types II (understanding, building, fixing) and III (programming and software development). Aylen was very confident about her depth of knowledge, as she comes from an electrical engineering background. She says:

> I absolutely understand the technology, I've written code that does TCI/IP transfers, and network, and http. So from just my background, I absolutely understand what's going on and why it's going on (Aylen)

Whereas in contrast, Anne confesses that she has a very "baseline" level of technology knowledge and cannot reach the depth that she perceives others have:

> I'm not an electrician, I'm not a BT engineer, so I'm relying totally on somebody's expertise to make it all function. So I couldn't program anything, I've used devices and things that are set up by somebody else, I couldn't program anything (Anne)

It is interesting that she perceived electricians and "BT engineers" as those having the expertise that she doesn't. This can be interpreted as her thinking that 'regular people' do not have these skills. However, she does later say:

> Even like teenagers, would be hugely more knowledgeable, because that's their gift, they love computer programming, they love technology (Anne)

which suggests that these in-depth technology skills are something ascribed to specialists and young people. However, only three participants claimed this knowledge: Aylen, Harris, and Daniel, one mature and two non-mature students respectively. Several of the non-mature students even explicitly recognise that they do not know technology at this level. However, some of the non-mature students do agree with Anne's opinion; Daniel expresses knowing how to code as part of the average young person's educational experience:

> We're being taught technology to be used for jobs that don't exist yet. We're being taught how to code, as well, it's just things that most adults just don't know or wouldn't want to learn any time soon. (Daniel)

One of the challenges participants presented about their technology knowledge was that technology is constantly changing. Chun has found that "technology has changed very fast" since she was in school. Harris says that:

> We know technology developed at a very fast pace in a way that those old technologies, […] they show up for one year, then they get vanished immediately because some new products, new technology come to replace them. (Harris)

In addition to changing technologies, participants recognised that their own knowledge was constantly changing, sometimes in response to a changing work environment. As Felix puts it:

> I think I'm getting there. Put it this way, it wouldn't be nine out of ten, but I've made improvements since I came here. Well, I had to do. […] If I go back four years, before I started at [local college], my level of computer knowledge was fairly limited. One of the problems now as I look back on it, I had a secretary for years and it was all over to her. Such things have changed. I don't think anybody has secretaries any more. (Felix)

Daniel's "shared language" comes up again as part of the knowledge theme. Once you have that knowledge, you can apply it across numerous other technologies. This knowledge of the shared language allows him to access new software and technologies easily, as he says:

> I've hardly ever had to learn software from scratch. And when I do, I just think it shouldn't be difficult, it shouldn't be difficult to learn how to use software. Once it becomes difficult, or once there's something I can't find, I become really unconfident with it. […] I'd know to look for [certain symbols], it's about that simple, I know those intuitive steps. If, as soon as I move to a platform that doesn't have that structure, I have no idea where to go by the help section [laugh]. (Daniel)

This indicates to me that familiarity and knowledge are explicitly linked, with familiarity being something of a sub-branch of type I knowledge (using a range of technologies).

### 4.7.6 Interaction

Interaction was a theme discussed a lot by the participants, with topics ranging from technology replacing face-to-face learning activities to others judging your abilities.

Technology replacing face-to-face interactions is often talked about in the media at the moment, with particular recent focus on replacements due to the coronavirus pandemic (Neate, 2020; Wootton, 2020). Participants expressed opinions that this replacement is both a good and bad thing. For example, Aylen, who teaches engineering, said that growing student numbers have become an issue for demonstrating in labs. Being able to replace in-person demonstrating with videos that students watch before the lab is beneficial. During her own studies, she liked that using technology gave her flexibility by replacing face-to-face sessions:

> I think that flexibility is really important. Especially for a lot of students today who are working because they are worried about their debt, they can't always get there at two o'clock, or they've parents to look after, or they've got people who are ill. […] We shouldn't be sat here insisting that students attend lectures, taking compulsory lectures and registers. I think that's just wrong. It's my choice. If I'm paying £9000, it's my choice whether I go to that lecture or not, And I should be able to get an online video, and I'll make my own time up when I have to. (Aylen)

Aylen's view that lectures should be made available by video so that students have a choice not to attend in person is interesting, and one I rarely hear academics state. Usually there is some concern that providing video captures of lectures will reduce attendance and that this is a problem (Dommett et al., 2019). Sophia, in contrast, labels herself as "a traditional kind of learner" who "enjoyed going to lectures, having the interaction with other people and with the professor". She finds it "a pity" that undergraduates have so much e-learning as she likes being in class. Having said that, she often recorded her lectures herself since she found some lecturers talked too fast or included too much information in a small space of time. She also admits that, "I used to take really crappy notes, I wasn't great at taking notes. So sometimes I had to go back and listen, so I think a mix of both is the right balance". In complete contrast with Aylen, she says "if you're paying tuition I think interactions with human beings is at least fifty percent need to be there". Perhaps a solution is in such things as lecture capture, which provides face-to-face opportunities for those who attend, but that are also recorded for students who require or want flexibility to access later.

Aylen also suggested that non-learning activities such as doing online banking and booking holidays on the Internet is more convenient than the old fashioned way of face-to-face, which also ties into the flexibility.

In addition to Aylen's strong views that technology is a positive thing, she also believes that not everything can be solved by replacing face-to-face with technology-based solutions:

> People learn from people, they like to see people, you can't replace everything with digital learning courses. And I think it's a fallacy that people think they can do that. And the problem is when people try and save money, it's an easy fix, but it's not the right fix. (Aylen)

Participants also worry about technology making us less sociable by replacing face-to-face interaction. Aylen finds mobile phones in particular "too pervasive":

> I think there's too many people glued to their mobile phones. You can't just sit down and have a conversation, write a letter, be with the people they're with. And you see when you go to the pub, when you walk into the pub, you'll have four people sat round a table, all on their phones. (Aylen)

Communication in general was something mentioned a lot by participants. Many participants use technology, particularly mobile phones and social media, as alternatives to face-to-face friendship maintenance. This was deemed particularly useful while "on the go". Some students felt that technologies such as voting systems reduce the difficulties of communication, particularly with groups of people rather than individuals:

> Daniel: Voting systems, it reduces a lot of communication.
>
> Rachel: Is that a good thing or a bad thing?
>
> Daniel: I think it's a good thing. Because trying to organise anything with a group which relies on its members is difficult, even just, "Shall we go watch a film?" That's simplified a lot more with a voting system.

Participants also suggested that technology assists rapid and accurate communication on courses, both with classmates and with lecturers. Participants enjoyed lecturers responding to queries and emails immediately. As Harris says:

> With the help of internet, I can type my question when I think of it, but in the past, if I were to walk to the office, I might forget the details of the questions, which is not good. (Harris)

Although email originated in the early 70s (Spicer, 2016) and is therefore not exactly a new technology, the smartphone allows lecturers and tutors to access their emails when not at their desks, allowing almost instantaneous communication (although the effect on the mental health and productivity of lecturers is another story (Dabbish & Kraut, 2006; Hair et al., 2007; Mark et al., 2012)).

Outside of the course, participants mentioned using social media to help them communicate with friends and family, maintaining these relationships from a distance. However some participants suggested that social media can be invasive, and some feel pressure to appear in a certain way on it. Sophia says that she found social media "a little bit superficial", as it's based around the sharing of photos, and she finds that "quite personal". A lot of my conversation with Sophia kept returning to social media. She labels herself as "very reserved and quiet and private", and explains that posting personal things or pictures on social media sometimes makes her feel anxious, particularly as she wants her family to see them, but not necessarily other people. She says:

> Unfortunately I can't block everything for everybody else. And it wouldn't be right either, other people do exist. (Sophia)

This idea that others outside your immediate circle of family and friends have a right to see what it going on in your life in interesting, and the fact that Sophia feels this way may give rise to her anxiety about sharing details of her life. How you look to others was a discussion that came up with several participants, and although discussions about this didn't focus exclusively on social media, it did come up as a point of concern, especially surrounding this sharing of personal information and the judgement that comes with that. This, therefore, is perhaps a drawback to technology for students.

As well as feeling judged on social media, students were often worried about using technology in front of others. Several participants expressed concerns about feeling judged for technology malfunctioning. Aylen says:

> If it doesn't work in front of the class, then that's the biggest problem. Because you don't want to look like an idiot. (Aylen)

Although this example by Aylen is when she is teaching, students also expressed these concerns about being looked down on for not being able to use technology, even when there is clearly a technology malfunction. Additionally, Harris feels threatened by people more experienced using technology than him:

> I sort of have higher level of confidence but if I met someone from the IT, probably they would crush my self-esteem [laugh]. (Harris)

This is interesting, since most students felt comforted knowing that support was there if they needed it. Anne talks about her husband and father in law who are both good with computers, and how she appreciates having that interaction with real people who can help in addition to the online resources she uses. However some participants felt that getting support from real people often took a long time. Aylen talks about a video she made being "embargoed in this no man's land" and how it took her six weeks until the university TEL team got around to uploading it to her course. Waiting in a queue can often take a long time, and this is a particular frustration for seeking IT support, especially as more and more people are using technology in their courses nowadays. This may put people off using technology, both as a lecturer and as a student. It's interesting that when I asked how often she needed support for technology, Aylen said:

> Well, as a student, I don't think I do. But as a lecturer, I probably contact the TEL team once a week. Because it's just these little quirks in [the VLE] where you go, "Why did it do that?". (Aylen)

Despite the long waiting times, Aylen seems to prefer contacting real people. Other participants mentioned asking friends, family, or classmates for help. Some participants expressed preferences for seeking support from resources online (e.g. YouTube videos), or instruction manuals. Most participants discussed seeking support from others and learning about technology from others. Chun says:

> If this thing, I never saw it, or never did anything related to it, I think I need support, to support me. For example, the software for the Endnote, in school, I never used it before, and I needed my classmate to teach me. And it's quicker than if I learn it by myself. (Chun)

This suggests that familiarity of a technology is a big part of whether the student attempts to learn by themselves, or whether they seek help. Out of those who said they would seek help, five said they would ask specialists (e.g. for specific things such as Excel pivot tables, or more generally, such as Google Garage or the library), two said they would ask classmates, two said they would use the Internet for help (e.g. forums or YouTube tutorials). Other sources of support mentioned were family members (particularly "a child", according to Julie) and the instruction manual. Felix, the eldest participant flat out refused to consider using the Internet for help, even when I suggested YouTube as a resource, which was interesting, preferring to engage in a face-to-face discussion with classmates as he labelled himself "fairly gregarious". Most of the sources of help mentioned were very much face-to-face interactions with real people, and there seemed to be no correlation with age.

Bill says that not only does he seek support for using technology, but he also seeks support for his studies from the same resources:

> If I don't understand something properly then I'll go on YouTube and try and find different videos of it and different explanations and videos. I find like that really really helpful. […] I think technology and the Internet makes things more clearer, which I think is one of the main benefits of technology and the Internet when it comes to exploring learning to a more suitable level to yourself. (Bill)

Several participants mentioned that technological learning resources helped them in their studies, and they found this a big advantage of technology, particularly the Internet. Technology affords us more interaction in the form of online resources. Several participants suggested that if the lecturers are not sufficient to provide explanations that are easy to understand, they could seek help from other experts, or even students, who have taken the time to produce websites, videos, or answers on forums. In this way, technology allows them to access group learning, even if they don't do it face-to-face.

Lecturers' use of technology affects students' interactions with both the material and the technology itself. Harris mentions that he dislikes Powerpoint, and explains that this is due to his lecturers' misuse of it:

> Harris: At first […] it's quite fascinating to have Powerpoint because all those colourful backgrounds, stylish words, blah de blah de blah… […] Most of the lecturers I had, they are probably, it's kind of rude to say this, but, they are more in the older generation ones, so the way they design Powerpoint is more to, like, chunk of words, chunk of words, then chunk of words.
>
> Rachel: Yeah. You don't think they adapted very well to what Powerpoint's supposed to be, they think it's just a new way of writing notes for them?
>
> Harris: Yeah. Probably. I mean, if they are going to do Powerpoint, in that way, I'd rather them to write on blackboard or whiteboard.

Bill also feels that lecturers don't know how to use Powerpoint, saying "I still see lecturers trying to like, fiddle around how to make a Powerpoint fullscreen". Many of the participants told stories about various technologies their lecturers didn't know how to use, and as a result, seemed to be less happy about that specific technology. This suggests that observed poor interactions with technologies can alienate students from them for the future.

### 4.7.7 Motivation

Motivation is a wide-ranging theme consisting of several subthemes. I will discuss each subtheme in turn below.

#### *4.7.7.1 Confidence*

In the interview, I asked students to rate themselves on a scale of one to ten for how confident them felt with technology, and how confident they felt when *learning about* technology. Tables 4.7.20 and 4.7.21 show the results from this question for the different age groups. Table 4.7.22 shows the difference between the scores given for each participant's confidence with technology and confidence learning about technology. However, the participant numbers are so small, that this may not be able to tell us much.

**Table 4.7.20**

*Confidence with technology for the different ages*

| | Confidence with technology (scale of 1 to 10) | | | | | |
|---|---|---|---|---|---|---|
| | 5 | 6 | 7 | 8 | 9 | 10 |
| 18-21 | 0 | 0 | 0 | 1 | 2 | 0 |
| 22-25 | 0 | 1 | 0 | 1 | 0 | 0 |
| 26-30 | 0 | 1 | 0 | 0 | 0 | 0 |
| 41-50 | 0 | 1 | 0 | 2 | 0 | 1 |
| 61-70 | 1 | 0 | 0 | 0 | 0 | 0 |
| Total | 1 | 3 | 0 | 4 | 2 | 1 |

**Table 4.7.21**

*Confidence when learning about technology for the different ages*

| | Confidence when learning about technology (scale of 1 to 10) | | | | | |
|---|---|---|---|---|---|---|
| | 5 | 6 | 7 | 8 | 9 | 10 |
| 18-21 | 1 | 0 | 1 | 1 | 0 | 0 |
| 22-25 | 0 | 0 | 1 | 1 | 0 | 0 |
| 26-30 | 0 | 0 | 0 | 1 | 0 | 0 |
| 41-50 | 0 | 0 | 0 | 3 | 0 | 0 |
| Total | 1 | 0 | 2 | 6 | 0 | 0 |

*Note.* The participant aged 61-70 did not answer this question.

**Table 4.7.22**
*Difference between confidence with technology and learning about technology for the different ages*

| | Difference between confidence with technology and learning about technology (both measured on a scale of 1 to 10) | | | | | | |
|---|---|---|---|---|---|---|---|
| | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
| 18-21 | 0 | 0 | 0 | 2 | 0 | 0 | 1 |
| 22-25 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 26-30 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41-50 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| Total | 3 | 0 | 1 | 3 | 1 | 0 | 1 |

*Note*. Negative numbers mean participant is more confident learning about technology than using technology; positive numbers mean participant is more confident using technology than learning about technology. The larger the magnitude of the number, the bigger the difference in confidence.

No participant rated themselves lower than five out of ten for either of the confidence questions. Overall, participants felt more confident using technology than they did learning about technology. It is interesting that the older age groups tended to score themselves as more confident learning about technology than using it, whereas there was an opposite, weaker trend for the non-mature students. This suggests that the mature students may be more confident than younger students when faced with new technologies, whereas the younger students rely on current knowledge they hold about technology. Confidence therefore links with the familiarity theme, and most participants suggested they were more confident with the technologies they use most:

> I think just the fact that I've used technology so much, I've adapted to it, like, a lot better than say, my parents, who have hardly been on technology. (Bill)

In fact, Anne explicitly says, "exposure makes you more confident, doesn't it". However, in contrast to this, she goes on to explain about her use of Excel at work. Although she attended a two-day course and used it regularly, she says:

> I think I never trusted it, because of all the formulas. Yeah the thing that I'm not confident with is working out formulas, so which is what you do in Excel, isn't it? (Anne)

This suggests that although Anne was familiar with the technology itself, sometimes the purpose of using it made her feel less confident. This has implications for the use of technology more widely, as it's not just the operational use that has to be learned, but the intricacies of how to use it for certain purposes. Not trusting a technology will mean that you have negative attitudes towards it, and this is clear in Anne's interview, as she brings up Excel as a point of contention multiple times.

I asked participants which technologies they felt most confident and least confident using. The results are summarised for each participant in Table 4.7.23, including a quote from each participant's transcript summarising their reasoning.

Nine out of the eleven participants state that the reasons for their most confident technology is familiarity, and five state unfamiliarity as a reason for being unconfident with technologies. Other reasons given involve the ease of use and suitability for purpose, both for most and least confident. There are no clear trends in reasoning across the age ranges, although the older age ranges seemed more likely to state hardware as their most or least confident, whereas the non-mature students tended towards software. This potentially suggests that older students are more likely to view software as integral to a piece of hardware and not differentiate between the two, whereas younger students may be more aware of the difference between them. Hardware is more often stated as a "confident" technology, and this does seem to be due to the familiarity aspect, or the "shared language" as Daniel puts it. This makes sense, because in software, each program has its own layout and particular way of functioning, but for hardware such as laptops, the layout does not change much between them.

Participants discussed the idea of technologies being easy. Daniel believes that well-designed software "shouldn't be difficult to learn how to use". Julie uses Macs preferentially because "everything's there, everything's easy", and Gwen says she enjoys using VLEs "because it's all there. You don't have to go anywhere else. It's very very easy to use". The idea of a simple system where everything is centralised seems integral to whether students find a particular technology easy or not. Daniel specifically links this to confidence, saying "once it becomes difficult, or once there's something I can't find, I become really unconfident with it".

Understanding the technology one uses can help increase confidence. This links back to the three types of technology knowledge, where the second (and third) types of knowledge involve understanding technology rather than just using it. Aylen rates herself as ten out of ten in confidence with technology, and reasons:

> So just from my background [as an electrical engineer], I absolutely understand what's going on and why it's going on. (Aylen)

When something is not easy to use, that can cause frustration. Aylen describes a time she was attempting to access a journal paper on the University library catalogue:

> Actually finding your way around journals, and catalogues, and getting past the Athens password, then the Elsevier password, and then somebody else's password. […] All you get is a brick wall that goes, "Oh, you haven't got the password for this" and I'm going, "But I know my Athens password, and I know this" so I would say that's probably the worst thing, that's the most disabler of being able to learn, which is really frustrating. (Aylen)

**Table 4.7.23**
*Technologies that participants felt most and least confident with, with reasons*

| Participant and age | Most confident | Reason | Least confident | Reason |
|---|---|---|---|---|
| Bill 18-21 | Internet | "I know how to research and use the Internet to my advantage" | Unfamiliar things | "I don't know what I'm doing" |
| Daniel 18-21 | Windows, Android | "I'd rather have something that does what I want it to do, and does it well" | Macs and MacOS | "I don't know it very well, and it's not as intuitive" |
| Emma 18-21 | Laptop, phone | "That's the ones that I use mostly" | Unfamiliar operating systems, new devices | "You have to kind of get used to what is different about them" |
| Chun 22-25 | Video editing | "I use it every day and I'm very good at it, I feel confident. It's about practice" | New software, complex things | "If I can use it but it's too complex" |
| Harris 22-25 | Internet | "Because you can't escape from that" | None | "At this moment, none" |
| Sophia 26-30 | Statistics programs | "I've mastered the thing that I usually test" | Social media | "I'm not confident in how people mostly use it" |
| Gwen 41-50 | Desktop | "I know how to use it" | Camera, online tutorials | "I just don't have the patience for them" |
| Julie 41-50 | Computer, phone, Sky | "It's what I've always used" | MP3 player | "That's the only thing, really, I don't use" |
| Anne 41-50 | iPad, internet | "Exposure makes you more confident" | Excel | "Never trusted it" |
| Aylen 41-50 | VLEs, simulation software | "[VLEs are] really easy to use" | Library/ journal catalogues | "I find it so confusing" – lots of different passwords |
| Felix 61-70 | Laptop, PC | "Probably because I'm used to them" | Smartphone, unfamiliar things | "I don't know that I am. Well for the stuff I use. If I was to get a smartphone tomorrow I might struggle" |

The complexity of these systems is obviously very frustrating for Aylen, especially when it prevents her accessing the knowledge and learning she wants. In my own experience, students have told me that they find navigating the library catalogue a particularly frustrating experience in the same way as Aylen. The issue of systems or hardware that are too complex was something that came up in several of the interviews with participants. Perhaps Daniel's "shared language" can help to ameliorate some of the frustration with complex technology, making systems user friendly and intuitive. As designers, perhaps we need to take care to produce systems that can be easily engaged with at a basic level, with additional options for sophistication at a deeper level once users have gained initial confidence.

Anne also gets frustrated with technology, particularly when it does not work as expected; however she takes a very equanimous view:

> You can lose data, you can lose something but it's not the end of the world. So I could use [technology], sometimes it's challenging, it's frustrating, it's annoying, but ultimately it's not the end of the world. (Anne)

This is obviously a healthy, balanced viewpoint to take, and an unusual one amongst my participants, most of whom said they would avoid using a technology if it made them frustrated, or find alternative solutions. Anne and Aylen were the only two participants to mention specifically that they weren't scared of technology. As they are both in one of the older mature groups (41-50), it is interesting that these participants went out of their way to assure me that technology didn't scare them, as this suggests that older people being scared of technology is an attitude they perhaps expected me to hold. This is consistent with the literature that suggests this is a common viewpoint, and while older students may not be 'scared' of technology, being perceived as such is obviously something they have to face, and are perhaps somewhat apprehensive about.

Worry about the safety of their online activities was another potential threat to participants' confidence, with several bringing up the idea of cybersecurity. It was mainly the younger students who expressed concern over this, however Aylen mentioned that her parents were worried about someone stealing their data if they used online banking or booking systems. Participants stated that worrying about cybersecurity is something that could affect how confident they were using the technology, and how much they trusted it, or their abilities to mitigate any dangers associated with it.

Some of the older students were concerned about how their younger family, particularly their children, were using technology. Anne told me:

> You probably won't get from anyone else, but my daughter's eighteen, so I know the password to her computer, so what leaves me anxious is sometimes when I'm reading what she's looking at, and what she's written in her messages, but also when I've finished, have I closed all the windows and left it as she left it. (Anne)

Moral and legal considerations aside, this is an interesting point. It seems that Anne does not trust her adult daughter to use technology responsibly. Others' online safety may therefore also be a worry for students.

In addition to confidence in technology, technology can also increase one's confidence in learning more generally. Anne credits technology in helping her to learn on her own:

> I'm surprised that I'm quite happy learning on my own now, so if I do quizzes and things like that. […] So yeah we have resources and online as well. You know, loads of things I've Googled. I've Googled how to fix a car! (Anne)

Several other participants also mentioned that they use technology to help them learn new technologies, either through using search engines like Google, online tutorials, or YouTube videos. As more and more people get access to the Internet that is cheap and accessible, it enables them to seek their own solutions, and learn new things without the requirement of face-to-face tutoring (Henderson et al., 2017), and this is true of learning technology as much as subject material.

#### *4.7.7.2 Purpose*

The purpose of technology was something that arose frequently in conversations with participants, and seemed to be something that they considered before choosing to use technology, or that they thought should be considered. In general, participants felt that technology should be used only when it makes their lives easier in some way.

Most participants felt that one of the advantages of technology was that it was useful, and often chose to use technology for that reason. Bill explains that technology can be useful for people with learning differences:

> I have dyslexia. I haven't done it yet, but I know there's [the disability and dyslexia service], I think it is. For example, there are different technologies out there, different programs and whatnot that can enhance one's learning even if they have a disability. But then I've also been to different workshops and stuff where they use like clicker voting thing, and kind of different interactions with the Powerpoint and stuff like that which I think is quite helpful. (Bill)

One of technology's most lauded advantages is that it allows students with learning differences or disabilities to access education and resources in a way that is more suited to them (Draffan et al., 2007; Pacheco et al., 2018). As well as assistive technologies, some technologies are particularly useful to people who work in certain disciplines or fields. Daniel mentions how in his engineering course, he was taught how to use specific software designed for engineers working in industry, such as ANSYS, an engineering simulation piece of software.

Many technologies that are designed specifically for one specialised purpose are not used widely across the population, but can be the go-to technology for that purpose.

In contrast, multiple participants consider paper versions to be more helpful in some circumstances, such as when reading longer pieces of writing. Bill feels that "it's just more connecting in a sense, the fact that it's in your hands", and Chun says "it's my habit to read on the paper, and I can take notes", saying that notemaking is something very important to her. She also likes "the feeling when you touch the paper, that feel is good". There is obviously therefore a balance to be struck between choosing technology or low-tech solutions, depending on which makes one's life or studies easier.

A lot of the choices of technology are for practical reasons, with ten out of the eleven participants stating that practical considerations are a big reason why they are inclined towards specific technologies. Aylen says:

> My phone's for texting my children, and that's about it. It's not for playing games. I use it for doing memo taking, when I'll suddenly think, "Ah, I must remember to do that tomorrow", so it's handy for stuff like that, but no, it's not entertainment at all. (Aylen)

Further, some participants only choose technologies when they feel they are absolutely necessary, for example for work or education. When I asked Sophia if she enjoyed using technology for learning, she said:

> Well you really don't have a choice nowadays. I'm ok with it. […] You just can't go about things without it. […] My cell phone is becoming like a laptop, you need it. So that's something that I'm starting to enjoy more, although in the past I've enjoyed it less. I was more reticent, not reticent, like, I wasn't a great fan of cell phones, let's just say that. (Sophia)

She explains that she's more of a traditional learner, and although she doesn't actively avoid technology, she often felt like she *had* to use it for certain things, particularly for communicating with her family who were overseas, or in emergencies.

The ability of technology to replace face-to-face communication was one of the main purposes that students chose technology. Videos replace lectures, and that's particularly useful for Aylen who likes to show lab demonstrations before the class by video, or feels that learning should be flexibly done anywhere and any time. This is explored further in Section 4.7.6 Interaction above.

Some participants also mentioned that technology is useful for receiving communication from lecturers. Daniel feels that:

> Daniel: [VLEs are] just a link between teachers and learners, students, so it's just another channel of communication. It reduces the work in some ways.

> Rachel: Ok. The work of the students, or the work of the teachers?
>
> Daniel: Both. I hope. [laugh]

In addition, students discussed how technology could be particularly useful for communication surrounding feedback. Aylen felt it was particularly useful in her studies for receiving instant formative feedback from her lecturers:

> Every probably four weeks, they would do, not Skype, but like a version of Skype, where somebody would go through the tutorial, and if you had a headset on, you could say, "Well I don't understand what happened on question four, why are you saying this, while I think this?". (Aylen)

She also finds technologies such as TurnItIn "an absolute godsend" for plagiarism checking. Likewise, Anne uses technology for "verify[ing] what you've learned", so she is constantly checking her learning using technology solutions. Receiving feedback in this way allows students to instantly address problems in their learning, and for distance learners such as Aylen, this was incredibly useful, but is reliant on how lecturers use it. Aylen goes on to say:

> I think the worst thing as a student is just inconsistencies. When you do have two different lecturers who do two different things, and one's got one type of video and one's got another type of video, and one doesn't do videos. I'm very confident with VLEs. The only limiting point is how good are the lecturers who are putting stuff onto it. (Aylen)

How well lecturers use the available technology was mentioned by several students. Some students praised their lecturers, however lecturers' misuse of technology, particularly Powerpoint, was also often discussed. On the whole, students were not patient with their lecturers not being able to use technology competently, which may negatively affect their learning. Harris also suggests his lecturers' misuse of Powerpoint has put him off Powerpoint for life, which may mean that if technologies are not well utilised, students may avoid that particular technology, even if it will be useful to them later in their academic lives. Participants felt that technologies had to be fit for purpose, and often lecturers were not able to use appropriate technologies that fulfilled this criterion. Participants felt that while using or watching someone use technology, they were assessing it for being fit for purpose. Daniel says, "For me, it all just depends on how well they work and how well they're designed", and that seems to sum up all participants' views. Harris says, "It sounds like, "Yeah, we use technology in our teaching", but is it really effective when it comes to enhancing learning?"

#### *4.7.7.3 Convenience*

Several participants talked about technology increasing the convenience of their learning. Chun speaks English as an additional language, and says:

I use the e-dictionary because it's hard for me to bring a big dictionary everywhere, and I need to check, what does it mean on the phone. (Chun)

The replacing of cumbersome books is something that multiple participants mentioned as a upside to technology, as well as e-books tending to be much cheaper than their paper counterparts. Additionally, the ability to access technology at any time is regarded by most participants as a good thing. I had this exchange with Daniel:

Daniel: A lot of technology is just made to be convenient. So most of the technology I use tends to make my life or my job more convenient for me.

Rachel: And what about it makes it convenient?

Daniel: It's the instant access at any time, on multiple devices in multiple places. I don't have to wait for a Monday, or I don't have to get up early for a piece of information or a submission, I can do that any time I like.

Most participants liked that technology allowed convenient and flexible access, whether to learning materials, tech support, or personal activities such as television and shopping. Aylen believes the flexibility particularly helps students who have part-time jobs or caring responsibilities. Julie discusses the benefits of having several different types of technology that allow her to choose which to use according to the scenario:

If I'm like at home, I can use my computer. Of which I actually have three of them. I've got a backup… Cause my auntie gave me a Windows one last year, but it's too heavy to bring here, so that's the backup and my husband uses that one. Then I bought one after Christmas that was lighter, to bring in, and then I've got a Macbook. So my Macbook's the one I use all the time, and then the others are just as and when I need them. So at home, I'll use my Macbook, but if I'm on like, on a train or whatever, I use my phone. (Julie)

Speed and efficiency are important to many participants, and they mentioned that fast access is an aspect of technology that they find both useful and enjoyable.

There's so much to [technology], like I mean like entertainment, you can use it for so many different things, and it's really useful as well, so like even finding this building, like Google Maps, it's easy to just do simple tasks and yeah, quick way to do it. And it's all at your fingertips as well. [laugh] (Emma)

As well as these accessibility issues discussed above, participants felt that technology allowed them to learn using their preferred learning style. It allows them to access learning resources in a more interactive fashion.

> I think that people with different learning abilities, we don't all learn from a blackboard or a pointer or reading off a book. […] I'm quite a visual learner, so kinda hands on, practical, so. (Anne)

> It's not just sitting there and looking at a piece of paper and trying to work out what somebody's saying, they're actually showing you on a video, or they're talking about it in a different way, or you're actually doing it yourself. (Julie)

This in turn seems to give students more ownership over their own learning. Most of the participants who mentioned this were mature, which is perhaps indicative of their recognition that this is a fairly new development in education. Mature students have often mentioned to me being in school, where the teacher has stood at the front and talked for an hour while they made notes, and thus mature students seem to be more aware and appreciative of the interactivity that technology allows.

#### *4.7.7.4 Barriers*

All participants talked about barriers to choosing or using technologies, whether barriers they have faced previously, or hypothetically.

**Table 4.7.24**
*Different age groups and if they feel they need support when using technology*

| | Feel support needed | |
|---|---|---|
| | Yes | No |
| 18-21 | 1 | 2 |
| 22-25 | 1 | 1 |
| 26-30 | 1 | 0 |
| 41-50 | 2 | 2 |
| 61-70 | 1 | 0 |
| Total | 6 | 5 |

Table 4.7.24 shows which age groups felt they needed support when using technology, either generally or specific technologies. Participants from all age groups felt they needed support, and there seemed to be no particular trends across the ages. For the most part, participants felt that they needed support for new or difficult technologies.

> Rachel: Do you feel you need support for the technology you're using?

> Anne: My day to day use, I'm ok. But definitely new resources, yeah.

Even Aylen, who rated herself ten out of ten in confidence using technology, reported a regular need for support:

> Rachel: And when you're using technology, how often do you feel you need support for it?
>
> Aylen: Well, as a student, I don't think I do. But as a lecturer, I probably contact the [technology enhanced learning team] once a week.

This suggests that the purpose for which technology is used affects whether students feel they need support. Aylen mentioned that she uses her institution's VLE in an advanced way to design her courses, and this is perhaps the reason why she feels she needs more support as a lecturer.

The kind of support sought differs between participants. Bill attempts to solve any encountered problems himself first, and then seeks support from the Internet. Only after that will he ask for help from "those who do know it so they can explain it to me" (Bill). This is a common workflow for many of the participants. In contrast, Felix, the eldest student, always asks for help from real people first. Chun assesses the situation before deciding who to ask for help – for the second (understanding, hardware, fixing) and third types of technology knowledge (programming, software development), she will go straight to a "professional", whereas for the first type (knowing lots of different technologies) she will ask her classmates. In all scenarios, participants considered the situation, and felt they would seek support from those they felt most comfortable in doing so, whether YouTube or an IT department.

I also asked participants whether they were ever anxious about technology. The results for the different age groups are shown in Table 4.7.25. Felix from the 61-70 group said he would not "admit" to being anxious when asked directly; however, earlier in the interview, he said he was scared of technology, so he has been recorded as anxious within this table. Table 4.7.26 shows the age groups and *when* they are anxious – before, during, or after using technology. Again, since Felix from the 61-70 group did not "admit" to being anxious, I did not ask the follow-up question of *when* the anxiety happened, and so he has been recorded as 'not anxious' within this table.

**Table 4.7.25**
*Different age groups and if they are ever anxious about technology*

| | Anxious | |
|---|---|---|
| | Yes | No |
| 18-21 | 0 | 3 |
| 22-25 | 1 | 1 |
| 26-30 | 1 | 0 |
| 41-50 | 3 | 1 |
| 61-70 | 1 | 0 |
| Total | 6 | 5 |

**Table 4.7.26**
*Different age groups and when they are anxious about technology*

| | When anxious | | | |
|---|---|---|---|---|
| | Not anxious | Before using | During using | After using |
| 18-21 | 3 | 0 | 0 | 0 |
| 22-25 | 1 | 0 | 1 | 0 |
| 26-30 | 0 | 0 | 1 | 0 |
| 41-50 | 1 | 2 | 1 | 0 |
| 61-70 | 1 | 0 | 0 | 0 |
| Total | 6 | 2 | 3 | 0 |

Tables 4.7.25 and 4.7.26 show that a greater proportion of the participants from older age groups are likely to be anxious about technology, and they are more likely to be anxious before using technology. This is usually due to being unfamiliar with the technology. This is in keeping with findings from Czaja and Sharit (1998), who found that attitudes (in their case, to computers only) are generally more positive post-task than pre-task. I had the following discussion with Gwen:

> Gwen: As I've learned, I think being very ignorant at the start made it very slow, scary at times, but as I've learned more and more, I would say yes, I do enjoy it. […]
>
> Rachel: Was it the unfamiliarity of things when you first?
>
> Gwen: Yeah, very much so. And Excel as well. Excel was just this huge scary big thing, but in actual fact, once it's taught to you and it's broken down, it's actually quite straightforward.

As she has said, she finds technology scary to begin with due to unfamiliarity, but then becomes less anxious and fearful whilst using it as she becomes more used to it. In contrast, the younger students who are anxious are more often anxious whilst using technology, and often give the reason as worrying about doing something wrong, or finding a technology complicated when starting to use it.

Four participants mentioned that they would be put off using certain technologies if they were unreliable. In our interview, Anne mentions her troubles with her satellite navigation system:

> Rachel: For your personal use, which forms of technology are the least enjoyable?
>
> Anne: Probably maps, when I'm driving sometimes. If it's a bit delayed on "turn left!" [laugh] and you've gone past, then.
>
> Rachel: Is this like a satnav?

> Anne: Satnav, yeah. So obviously great again having it, we don't have it on the car, but we have it on the phone, so, yeah. That's quite annoying, or when you're out in the countryside and you can't load to get to your next destination. Yeah, that's probably the most annoying.

Anne later discusses how it's frustrating when there are problems and she doesn't have time to sort them, and "for every gadget you have, it can go wrong, can't it, so. It'd drive me nuts! [laugh]" (Anne). This unreliability seems to be a barrier to Anne, who expresses frustration with these types of technologies. Along similar lines, Daniel talks about outdated information:

> If the quality of the technology is good, or if the version is new, then I'll be confident I'm probably going in the right direction. But if it's old, or if some information is wrong, I'm always constantly doubting myself. If I'm on a website, I'll think, "Oh I should probably just use another website, another website to be sure", if it's an app, I might just think, "Oh it doesn't look very good" or "Oh, this link doesn't really work" or "Oh, this is basically a website", I just won't have the app, and I'll use the website instead. (Daniel)

Daniel specifically says he will choose not to use a particular technology if it is unreliable, outdated, or just poorly designed, so this is obviously a big barrier for him. This also links to trust. Participants may choose not to use technologies that they do not trust, such as Daniels' examples above. Aylen discusses:

> I still can't get my head around in-class voting. I've tried it twice, and both times the technology has bombed. […] And once you've done that twice, you sort of go, "I haven't got time to do this any more". (Aylen)

Having the voting systems she has chosen fail to work means that she explicitly refuses to use them any more. Several participants told stories of a time that their technology failed, a common example being essays getting lost when the students relied on the autosave feature instead of manually saving. In an example of this, Chun says, "It made me don't trust it." Unfortunately, word processors and other software are an integral part of university study, and therefore they are not easily avoidable; however, several students in my classes have mentioned to me that they have switched to Google Docs, since it autosaves regularly and reliably, due to the data being stored online in the Google Cloud.

In addition to reliability, two of the participants mentioned that they often worry about how fragile some technologies can be. Aylen avoids expensive smartphones after noting that many students have smashed screens, saying "I haven't got [an iPhone], I have a cheap phone, so it's not a problem". Julie also says:

> We need a new TV though, and I really don't like these new ones that are really thin, because I have cats, and they're shut in the living room at night, and I'd fear ten cats plus one flimsy little telly is not a good match. (Julie)

Both of the participants concerned about the fragility of technology were mature students in the 41-50 age group, so perhaps this could be indicative of a difference between mature and non-mature students, and how they choose which technologies, with more mature students choosing more robust hardware, which may mean eschewing newer models that are more focussed on slim, lightweight designs.

Expense and cost was also a reason given by a range of students for avoiding technology. Daniel feels that there is a socioeconomic barrier to overcome in order to get a Mac, and he doesn't feel comfortable with that, so he sticks with cheaper Windows machines. Julie also agrees that Macs are more expensive, but feels that the benefits outweigh the cost. She talks about her 2008 MacBook, saying, "They last forever, and the one I've got is just as up to date as the ones that are out now. That's the thing with an Apple."

As well as socioeconomic barriers, several participants recognise that there are issues of access to technology that affects the uptake. Anne says:

> There's also a load of people out there that don't have access to half what we have access to, so their knowledge will be limited, […] just because they weren't able [to access it], not because they weren't capable. (Anne)

She goes on to say that access has increased substantially in recent years, and that her daughter's secondary school allows people without computers or internet to use theirs, which is a good thing. In addition to access to hardware, some participants discussed how it was sometimes difficult to access academic materials.

> I don't like reading articles or books online, I like a book. Or if I can't, you know, I need to print it off. If I have to read something online and it was frustrating because there were some things that limited what you could print. […] Some of the articles that we used in like history, you couldn't print off the whole thing, it would only let you print five pages of a twenty-five page thing, it was like, well what's the point in that? (Julie)

Two of the younger students mention that cybersecurity is something that concerns them. Bill mentions he keeps blu tak over the webcam on his laptop, and he worries about a "Black Mirror situation". Similarly, Harris talks about how his knowledge of technology allows him to stay safer whilst online.

Three of the participants who choose not to use much technology for their personal use suggest that they are put off technology by it being too pervasive. Sophia says:

> I'm not always on my cell phone, whereas I see younger people usually, and their cell phone is like part of their hand. They're always there and it's something that bothers me because I don't need to look at my cell phone all the time. (Sophia)

While Sophia suggests this is an affliction of young people, Aylen says that it's a problem with people of all ages, and that phones should be functional, not to dominate your life. Interestingly, these same three participants are also the only ones to mention gender when discussing technology, all implying that men and boys are more interested and knowledgeable about technology (all three participants presented as female). Perhaps their individual lack of desire to use technology much means that they fall prey to gender norms, interpreting their own disinterest as universal for women. Women being less interested in technology than men is a common stereotype, but in my own classroom and life experience, I have not noticed much of a gender difference. Having said that, there is a fair amount of literature on gender differences in use and attitude to technology that asserts that, generally, males are more positive towards technology, but with small effect sizes (Cai et al., 2017).

As well as technology being pervasive, some participants felt that technology was a distraction in their lives, both in a negative and positive way. Bill says:

> Obviously a laptop can be quite distracting when you're learning, so for example I've just come from the library, and I've just spent half an hour on Twitter, so. [laugh] (Bill)

Bill finds he often drifts off into unrelated activities when he's trying to work on his laptop, and one of his solutions is doing his course reading on paper rather than on his laptop. In contrast, Harris presents a more balanced view, where he views technology as a reward for good work:

> I treat it like some kind of rewarding surprise. Even though it's just five minutes on some mini games, or just to do something you like through technology. But like I say, because of that addictive behaviour, how many five minutes you have during the day. It could be summed up into two hours or more than that. (Harris)

At the other end of the spectrum, Julie, who has multiple laptops, uses particular laptops for particular activities:

> So I know, I'm in a different work mode when I've got this computer out. Yes, it's, "I've brought this computer downstairs, so I'm actually working now, I'm not on that one!" (Julie)

Julie obviously finds it useful to differentiate her work and her pleasure activities in this way, which is an interesting use of technology, as it functions in almost the same way that Bill is using paper reading to ensure he does the work, and then the laptop is for his pleasure activities. Even Daniel says that his least enjoyable technology to use is a computer:

> In my own free time I associate the computers and the book things with just work I have to do, so whenever I have my own time to enjoy myself, I

> don't want to be fixed to a computer screen, I don't want to have to go through websites, like it's just too much. (Daniel)

This is an opinion shared by Aylen, who chooses not to use technology in her free time because her work life is spent programming computers, and she would rather disengage from technology while relaxing at home. This is not necessarily a barrier for using technology for learning, although it is obviously a barrier for using technology more widely.

Daniel also points out that he resents technologies he feels pressured to use:

> It being forced upon me wasn't really entertaining at all. (Daniel)

From these comments, it appears that we should be giving students the option to use one of a range of technologies, or perhaps just to opt out of a particular technology altogether.

#### *4.7.7.5 Enjoyment*

I asked participants whether they enjoyed technology for learning, and also whether they enjoyed technology more generally. Table 4.7.27 presents the results.

**Table 4.7.27**
*Age groups of whether they enjoyed technology for learning or technology generally*

| | Enjoy technology for learning | | Enjoy technology generally | |
|---|---|---|---|---|
| | Yes | No | Yes | No |
| 18-21 | 3 | 0 | 3 | 0 |
| 22-25 | 1 | 1 | 2 | 0 |
| 26-30 | 1 | 0 | 1 | 0 |
| 41-50 | 4 | 0 | 3 | 1 |
| 61-70 | 1 | 0 | 0 | 1 |
| Total | 10 | 1 | 9 | 2 |

All but one participant enjoyed using technology for learning, whereas two participants did not enjoy using technology more generally. Those who did not enjoy using technology generally were from the oldest two age groups, however there were plenty of mature students who do enjoy using technology more generally, so perhaps we cannot draw too much from that, particularly since the student who didn't enjoy using technology for learning was non-mature.

I also asked participants what their most and least enjoyable technologies were, both for learning (Table 4.7.28) and for their personal use (Table 4.7.29).

**Table 4.7.28**

*Technologies that participants felt were most and least enjoyable for learning, with reasons*

| Participant and age | Most enjoyable | Reason | Least enjoyable | Reason |
|---|---|---|---|---|
| Bill 18-21 | Internet* | "I think technology and the Internet makes things more clearer" | Reading on the laptop | "A laptop can be quite distracting" |
| Daniel 18-21 | Phone* | "The software's a lot better designed" | Particular apps or websites | "If I don't like the website I will try my hardest not to use it" |
| Emma 18-21 | Videos | "It makes it easier" | Particular designs or websites | "Where it's really hard to access, just because the design of it is not very like well-designed, or complicated to use" |
| Chun 22-25 | Computers | "Watching film! And editing" | New software* | "I need to set up it on my computer and this process is really difficult" |
| Harris 22-25 | VLE and email | "Everything is there" | Powerpoint | "You are just fascinated by all those high tech features but the knowledge doesn't look high tech" |
| Sophia 26-30 | Downloading articles | "I use [it] the most as a PhD student" | None | "I'm a more traditional learner" |
| Gwen 41-50 | VLE | "It's all there. It's very very easy to use" | Phone | "Because I haven't used them" |
| Julie 41-50 | Computer* | "It's not just sitting there and looking at a piece of paper" | Powerpoint | "There's all these long posh words in it, or there's only bullet points about certain things" |
| Anne 41-50 | Quizzes | "Where you can get an answer" | PebblePad | "It was a glitch in technology and that's frustrating" |
| Aylen 41-50 | Videos | "Easier to just see a face and listen to someone talk" | Online quizzes | No reason given |
| Felix 61-70 | Word | "Sense of achievement" | Excel | "Lack of experience" |

*Note.* * indicates that the technology mentioned is the same as the technology with which the participant was most confident

**Table 4.7.29**
*Technologies that participants felt were most and least enjoyable for their personal activities, with reasons*

| Participant and age | Most enjoyable | Reason | Least enjoyable | Reason |
|---|---|---|---|---|
| Bill 18-21 | Internet on laptop*† | "I tend to just like wander around on the web" | Radios and TV | "I can't stand adverts" |
| Daniel 18-21 | Phone*† | "I want to do that as quickly and easily as I can" | Computer | "I associate the computers with work I have to do" |
| Emma 18-21 | Media† and social media | "Entertainment and getting in touch with friends" | Obsolete devices | "Have less kind of use" |
| Chun 22-25 | Social media | "To communicate with others" | Social media | "Oh I don't want him to see my personal information" |
| Harris 22-25 | Software | "The only feasible way for me to maintain my chess level" | None† | "There aren't any unsatisfied ones" |
| Sophia 26-30 | Streaming | "I've become addicted to TV shows" – to avoid loneliness | Phone | "I don't like to depend on things and they looked antisocial" |
| Gwen 41-50 | None | "I'm quite backward at home" | None | "I don't put myself in the position" |
| Julie 41-50 | Computer*† and social media | "It's usually Facebook or something like that" | Word | "That's not fun, you're actually doing something" |
| Anne 41-50 | Media and social media | "Keeping updated" | Satnav | "It's always with something that doesn't work" |
| Aylen 41-50 | None | "I would probably avoid it at all costs" | Phone | "I find them too pervasive" |
| Felix 61-70 | Laptop, PC† | "Every now and again I use Ebay, I send email to some friends" | TV | "I like silence. I like reading. And I like the garden" |

*Note.* * indicates that the technology mentioned is the same as the technology with which the participant was most confident; † indicates that the technology mentioned is the same as the technology enjoyed most for learning

Participants gave several reasons as to why they enjoyed or did not enjoy technology. Harris recalls a time when he was excited by technology:

> I'm more excited to use technology because I still remember the time […] [the primary school teachers] managed to pair the computer screen to the television screen and as a kid, I was impressed. (Harris)

He goes on to explain that his excitement varies with the stage he is at using a particular technology:

> At first, before using or know the function of it, I believe that anyone will be like me, what this thing going to do in my class or in my lectures? So after you realise the function of it, you found that, woah, this experience is kind of exciting. [Harris]

Harris' excitement about using technology is different depending on the scenario. As a child, he was excited about any technology, and this was because it was novel to him. However, as an adult, he is apprehensive about new technologies until the purpose is apparent, and only after that is he able to get excited about new technology. This is an interesting difference between technologies attitudes in children and adults, and recalling my own experience, this matches up rather well. As a child, any use of technology was exciting; however as an adult I reserve judgment until I know the task or purpose for new technologies.

This may be related to novelty. Although new technologies encountered as an adult are novel to the student, the concept of technology as a whole is more novel to children, which may be why they get more excited about it. Novelty is one of the reasons participants found technology enjoyable. Chun thinks some of it is a function of age:

> I'm not the one eager to accept new things, but I think the younger one, especially born after the new century, they like it, they like the new things, because they're cool, they're fashion. (Chun)

Perhaps this is a generational thing, or perhaps it is simply age, where younger people can be more excited by technologies. This would certainly fit with Harris' experience.

In terms of enjoyment, Emma suggests that novelty actually turns her off from using new technologies. We discussed virtual reality, which is a relatively novel technology. She says she would be interested to try it out, but she "wouldn't feel as confident" since her "mind doesn't naturally go to those things, it kind of just goes to what [she's] using, and what [she's] comfortable with" (Emma).

Participants said that whether they're interested in a particular technology affects whether they enjoy it. Several of the older students mentioned video games. Aylen says:

> It's a bit of fun when you go on the Wii, or the Playstation, but I find I'm bored within fifteen minutes of how many different ways can you jump up this wall, how many times can you fall into that river and have to restart. It's just not interesting. (Aylen)

Bill links his knowledge to that of his friends. He talks about type III knowledge (programming and software development), which he has "no idea about":

> My friend's doing a coding course right now, which she's interested in, but then, it depends like what your interests I guess is. (Bill)

He suggests that the desire to obtain higher levels or types of technology knowledge is driven by interest. This is mentioned by several other participants as well, especially the non-mature students. Emma, Felix and Gwen mention that there are particular technologies, such as social media, or smartphones, that they haven't bothered to learn and don't want to, simply because it doesn't interest them. They also suggest that purpose is a big part of whether they enjoy learning about new technologies.

Gwen discusses how challenging herself and learning more is a part of her technology enjoyment:

> Rachel: And do you enjoy using technology generally as well?
>
> Gwen: I didn't particularly a few years ago. I mean I've had to use it for work but that was quite contained, it wasn't particularly stretching yourself. But no, I do enjoy it, I would say I do. As I've learned, I think being very ignorant at the start made it very slow, scary at times, but as I've learned more and more, I would say yes, I do enjoy it.

This feeds into students' desire to learn. All participants talked about their desire to learn new technologies, or current technologies better. Anne doesn't want to learn if she doesn't enjoy something, saying:

> Anne: I can't play Xbox stuff, I just can't get that control.
>
> Rachel: Is it kind of, the dexterity thing, or…?
>
> Anne: Yeah, and it must be the visual, spatial awareness with the dexterity.
>
> Rachel: Right ok.
>
> Anne: So my things always fall into the water, or it just doesn't… yeah. And I have no pleasure in doing it, so I'm not going to learn, I'm not going to want to do it, I don't enjoy it, so I just join in because I feel I should as a parent sometimes. It's not my pleasure.

Chun links her desire to learn to the purpose of the technology:

> I mean I can learn it, but the problem is, sometimes I don't want to learn it. If it is not necessary I won't pay much attention on it, because now all the things is enough. They can support all my work, so why I need to learn a new technology? (Chun)

If she doesn't feel the technology adds anything to her work, she won't bother to learn it, although she rates herself as quite good at learning new technologies. Aylen only enjoys using technology when she feels it's saving her time. Daniel also suggests that purpose has quite a big effect on his desire to learn. He believes "We're being taught technology to be used for jobs that don't exist yet", and this is a big factor in his desire to learn. Several of the younger participants echoed this kind of thought, that technology is increasing in our lives, and it's therefore important to learn it.

The older participants, however, suggest that the driver of their desire to learn is whether they need to know the technology *now*. Felix found he needed help with his "internet skills" for his course, and says:

> I've just started now going to the Google Garage, which is a new shop [in the town centre]. […] I saw it as I was coming back from here, went in, and said, "Look, I could do with some coaching on internet skills". (Felix)

Some of the older participants suggest that their desire to learn is very much controlled by how complicated the technology is. Gwen says:

> I've got a camera and I can just use the basic functions on it, but it's awful, I just can't be bothered to learn all the different functions because it seems so complicated. (Gwen)

Several participants said that their enjoyment has changed over time. In most cases, enjoyment increased: the reasons given range from enjoying technology more when it's more familiar (Gwen), to the technology itself changing to be better. However in some cases enjoyment decreased, as participants got bored with specific technologies.

#### 4.7.7.6 Design

Design is another factor that affects participants' motivation to use technology, particularly specific technologies. The design of a piece of technology encompasses several different factors.

Formatting and layout were mentioned by several participants as factors in whether they choose a technology. Daniel prefers the layout on mobile phone apps to websites because:

> The software's a lot better designed, the layout is a lot easier to understand, it's a lot more compact on a phone, 'cause the point is to try and get everything on a small screen, with few buttons. (Daniel)

He also says that simple layouts are more likely to plug into the "shared language" of technology, automatically making them easier to navigate and understand. Emma says that she dislikes formats where features are hard to access, or where the design is too complicated. She labels herself as a "very aesthetic and visual" person, so values the visual design of platforms. She says she prefers Android over Apple phones as she thinks the iPhone OS is "quite cluttered".

Anne also feels undue complexity hinders her understanding and confidence to use technology, in layout as well as the actual processes:

> Anne: So on a computer screen, having lots of numbers, lots of figures, and trying to put them into an order. That would just visually, that would- I'd need to break it down a lot smaller. That would just start me thinking, "Oh, this is too much, this is too complicated".

Most participants prefer layouts that are simple, with easy processes. Cluttered layouts are deemed undesirable and difficult to navigate, and this can deter participants from putting in any effort to engage with the technology. Gwen describes some technologies, particularly the university library catalogue website, as being "hard to get to grips with, cause it's so big, and there's so many different things". It's easy for students to feel overloaded by technology. Again, designs that are simpler are more desirable to use. There is also something perhaps to say about the organisation of the material. If there are lots of different parts to the website, these could be clearly delineated and labelled. Daniel suggests that platforms being customisable is a good way to avoid this problem. He says:

> Rachel: And is this customisability something that's important to you?
>
> Daniel: Yeah, yeah. It's that I'll know I'll want to change something, if I don't like it. I'll know that if I want to get somewhere easier, I know I can make it easier for myself, rather than having to work around something.

Gwen also discusses an online teaching English as a foreign language (TEFL) course she did, and found really useful. She particularly liked the design of that course:

> Gwen: Very easy to use. So simple to use.
>
> Rachel: What made it easy?
>
> Gwen: It was just step by step. I didn't get lost any time, it was very very easy. I think they make it pretty foolproof.
>
> Rachel: Did they give you instructions for every step?
>
> Gwen: Yes. Yeah, everything was clearly lined up and you just moved on and then it had your marking. […] It was very well laid out.

In addition to simple, well-designed layouts, resources can be viewed as easier to navigate when they have instructions, and where processes are broken down into small steps system so that the user doesn't get overloaded. An alternative to this is to use the standardised format that Daniel identified as the "shared language" across devices. Students often find these standardised layouts intuitive – although in which direction the causality lies is an unknown. Standardised or intuitive formats enable students to minimise the number of new concepts they have to learn in order to engage with new technologies, and results in an overall simpler experience.

Students have so many different technologies to choose from, sometimes they are reluctant to learn new technologies that they feel are redundant. Chun says:

> Chun: If [the technology] is not necessary I won't pay much attention on it, because now all the things is enough. They can support all my work, so why I need to learn a new technology? That complicated things.

This ties back in with the Purpose theme, as students must be convinced that a particular technology is useful to them in order to want to use it. This also encourages students to remain updated with technology. Sophia says:

> Sophia: There's people who grew up in 60s and 70s who loved technology, they saw it being born and evolve and just kept pace with that, and other people who didn't care, didn't really bother to grow with it.

This idea that when you find technology useful you 'grow with it' is interesting since it implies that using technology for a purpose is a motivating experience. It may also mitigate the effects of changing designs that may otherwise dishearten and alienate students.

Students often linked interactivity in technologies to being useful and enjoyable. This was more when they were thinking about technologies they used for learning. I have covered Usefulness and Enjoyment in previous sections, but the interactivity of a technology is part of the design – whether it's a single technology type, such as quizzes (mentioned by Aylen), or part of a wider lesson pedagogy.

Specific design criteria students mentioned wanting for interactive materials include:

> You watch a video and answer a question (Aylen)
>
> They're not moving quick enough. […] They just take too long. And they're a bit boring. (Gwen)
>
> It's hands-on. […] The videos have been- they have been helpful. (Julie)
>
> They're actually showing you on a video, or they're talking about it in a different way, or you're actually doing it yourself. (Julie)

To summarise, students want well-paced materials, including videos, questions on those videos, and opportunities to try doing the activity yourself.

Overall, however, students want the design of their learning materials and platforms to be good quality. They are frustrated by poor design:

> It all just depends on how well they work and how well they're designed. (Daniel)

Therefore the design of a platform, the design of the technology, and the quality of the learning resource itself are all considerations when we create or implement learning materials for students.

### 4.7.8 Overall Attitude

Table 4.7.30 shows the participants and what percentage of their overall interview was coded as a positive or negative attitude towards technology, and whether their interview was overall more positive (a positive difference) or more negative (a negative difference).

**Table 4.7.30**

*Participants and positive or negative attitude percentage*

| Pseudonym | Mature? | % positive | % negative | % difference |
|---|---|---|---|---|
| Bill | No | 41.92 | 30.71 | +11.21 |
| Daniel | No | 24.33 | 17.52 | +6.81 |
| Emma | No | 20.06 | 21.02 | -0.96 |
| Harris | No | 35.27 | 24.70 | +10.57 |
| Chun | No | 8.44 | 22.31 | -13.87 |
| Sophia | Yes | 10.90 | 23.82 | -12.92 |
| Julie | Yes | 27.50 | 8.25 | +19.25 |
| Anne | Yes | 20.89 | 19.98 | +0.91 |
| Aylen | Yes | 26.29 | 30.21 | -3.92 |
| Gwen | Yes | 34.70 | 21.94 | +12.76 |
| Felix | Yes | 27.61 | 22.81 | +4.80 |

60% of non-mature students and 67% of mature students were more positive overall. Non-mature students had an average difference of +2.75%, whereas mature students had an average difference of +0.46%. There is therefore no sharp difference between the ages, and a Mann-Whitney U Test confirms this lack of significance. The most positive student (Julie) was mature, and the most negative student (Chun) was non-mature.

## 4.8 Summary of the Key Interpretations of the Data

This section presents a summary of the key interpretations from the questionnaire and interview results and analysis.

### 4.8.1 Questionnaire

For most technologies, there was little difference in usage patterns across the age groups, for course activities, non-course activities, and both.

The mature students used significantly fewer technologies than the non-mature students for their course, and generally. However, there was no difference in the number of technologies used for non-course activities.

The mature students used technology less often than the non-mature students.

The mature students used technology for a longer period of their lives than non-mature students. There was also a significant difference between the smaller age groups.

Two attitude factors were found: confidence and technology use. There was no difference between the mature and non-mature students for either of the factors, nor for the overall attitude. There was a small difference between the smaller age brackets for attitude to technology use.

The younger students felt that technology stops them being bored more than the mature students. The younger students were also more likely than mature students to feel like they needed more training to use technology properly.

### 4.8.2 Questionnaire Open-Text Comments

Three themes were identified from the thematic analysis of the comments: knowledge; confidence; and utility. Two of these themes were the same as the factors identified in the EFA.

Older students are more likely to want training and support to use technology. Older students are also more concerned about their perceived knowledge level.

Although a small sample size, some differences in attitudes between the disciplines were apparent, with the science and social science students being more likely to think technology is useful, whereas the arts and humanities students tended to have more negative attitudes towards technology and put more emphasis on analogue solutions. There therefore may be more of a difference in attitudes to technology between disciplines than between age groups.

### 4.8.3 Qualitative Interviews

Five themes were identified from the thematic analysis of the interview data: age; knowledge; familiarity; interaction; and motivation (which has six subthemes). The motivation subthemes are: enjoyment; convenience; purpose; confidence; barriers; and design. The three themes previously identified from the open-text comments (knowledge, confidence, and utility) are the same as themes in this list (where utility is another word for purpose).

Students defined 'technology-enhanced learning' in two main ways. The first was to give examples of the technologies themselves, which is a common misunderstanding of the definition of TEL. The second way was to talk about teaching enhancements beyond lecturing, including providing channels of communication.

From the thematic analysis, I identified three types of technology knowledge from students' comments: type I technology knowledge was knowing how to use a range of technology on a practical basis; type II is understanding, building, and fixing, usually hardware; and type III is programming, software development, and other "professional" knowledge.

Older students were more likely to think of technology as hardware, whereas younger students were more likely to view technology as software.

Although broadly, students are more confident actually using technology than learning about it, the older students claimed to be more confident learning about technology than using it. The older students are also more confident with newer technologies than younger students, and were viewed as more adaptable. As well as being more comfortable learning newer technologies, the older students also seemed more familiar with unusual technologies. Younger students tend to view learning technology as a skill for the future, whereas the older students viewed it as something they need to know now.

Participants from all age groups felt they needed support generally to use technology, and there were no age differences. In terms of the type of support sought, students of all ages often tried to solve the problem themselves using the Internet, then asked real people if that didn't work.

Most participants said they enjoyed using technology for learning, as well as generally. Those who said they did not enjoy using technology generally tended to be older. Some students enjoy the challenge of learning new technologies.

The participants felt that having higher levels of perceived knowledge about technology increased their confidence with it. They also mentioned that having technology knowledge allowed them to stay safer online, which increased their confidence; cybersecurity was a particular concern for younger students.

All students felt like they had a similar knowledge level to their friends and people the same age. However, when asked to compare their knowledge level to people of different ages, the answers were different. About a third felt they knew more than younger people and two thirds felt they knew less, though this did not correlate with age. However, in different parts of the interview, the older students expressed opinions that children are very capable with technology. Furthermore, all students felt more knowledgeable than people who were older than them. Older students felt they knew less than their family, whereas younger people felt they knew more.

The older students generally did not like being perceived as scared of technology.

Students felt that familiarity and exposure with a particular technology leads to higher confidence, higher level of enjoyment, and a more positive attitude. They also felt that new or novel technologies were generally enjoyed more initially, and they were excited to use them. As time passed, the enjoyment of the technology either increased as they gained familiarity with it, or decreased due to boredom. Participants also recognised that technology was constantly changing, and this was perceived as a barrier.

Unfamiliarity with technology causes anxiety and lower confidence, particularly for the younger participants. This is in contrast to the view expressed by participants that younger people have grown up surrounded by technology, and therefore find it easier to use and are more confident with it generally.

All participants were more confident with technologies that they viewed as suitable for purpose, and were aware that different types of technology are available for different circumstances. All participants thought about the purpose of a technology before choosing it, or acknowledged that they should. Purpose and usefulness were the main reasons the students chose to use a particular technology, and they were generally apprehensive about new technologies until the purpose was clear. If the technology was not necessary, they would generally not choose it.

Some purposes that students mentioned as being particularly important to them include:

- Giving students ownership over their own learning (this was particularly noticed by mature students)
- Convenience – for learning and generally
- Saves time
- Fast, efficient access
- Flexibility in time and place, for learning and generally
- Replacing face-to-face interaction (both a good and bad thing)
- Maintaining relationships and friendships is easier
- Course communication rapid and accurate
- Receiving instant formative feedback, particularly in lectures
- Enables access to group learning
- Study support and extra explanations
- Check and verification of learning
- Increases confidence in the subject material
- Enables students with learning disabilities to access education and resources
- Enables students to use their preferred "learning style"
- Differentiating work and leisure activities

- Learning new technologies using current technology (e.g. the Internet)
- Particular fields need specialised equipment and software

However, students will also choose analogue versions rather than technological versions, depending on which makes a task easier (e.g. paper for notemaking).

The purpose of the technology was a determining factor in whether students felts that support was required. Students felt that support was needed for new or difficult technologies, and the level of familiarity they had with a technology determined whether they would attempt to fix it themselves or seek help. They felt comforted knowing that support was available, even though it sometimes took a long time to receive.

The older participants were more likely to be anxious about technology before using it, whereas the younger participants were more likely to be anxious while using it, usually due to fear of doing something wrong, or if they found it complicated. Older students were also anxious about how their family used technology.

Participants discussed how they may avoid technology as they find it a distraction, and sometimes make active attempts not to succumb to addiction. Students of all ages felt that technology can be too pervasive and make us less sociable, and that technologies such as social media are invasive.

The participants were less likely to use a technology if they felt it was unreliable, outdated, or redundant. If a technology fails, the student feels judged, so they avoid technologies that they don't trust, or that are not well-utilised. When a technology is difficult to use, including with complex layouts that increase feelings of overload, they stop wanting to use it, and their confidence is reduced.

Educators' use of technology affects students' attitudes. Students felt that lecturers' misuse of technology due to lack of skill or utility led to them having negative attitudes about it. Students also mentioned that they resented being forced to use particular technologies.

The students sometimes chose not to use expensive technologies, even though they viewed them as longer lasting. The older students in particular avoided technologies they thought of as fragile.

Participants' desire to learn a technology was often driven by purpose, difficulty, and complexity. Other drivers included interest and enjoyment.

Technologies were often chosen or rejected by participants due to their design. Formatting and layout were identified by students as important, with simpler layouts being more popular. Customisability can circumvent design problems, and attract users. Students felts that well-designed software should be easy to use, with some degree of centralisation.

Participants talked about a “shared language” that applies across most modern technologies. Using a wide range of technologies allows students to learn this universal iconic language. Standardised formats using this shared language reduces cognitive workload for students when learning new technologies or concepts, and can help reduce the frustration of complex tasks. Simpler designs and layouts usually adhere to the shared language rules.

Interactivity in technologies and learning resources was felt to be useful and enjoyable. Technology can enable communication between learners and educators, and clear instructions are often the first point of communication.

Design criteria mentioned by the participants included:

- Well-paced
- Good quality content
- Videos
- Questions and quizzes
- Opportunities to “have a go” themselves

# 5 Discussion

In this chapter I discuss each research question in turn, and synthesise the quantitative and qualitative results for each.

## 5.1 Types of Knowledge

From the thematic analysis of participants' interviews, I identified three types of technology knowledge, as described in Table 5.1.1.

**Table 5.1.1**
*Types of technology knowledge identified from the interview participants' comments*

| Type of knowledge | Description |
|---|---|
| I | Knowing how to use a range of technologies; practical use |
| II | Understanding, building, fixing hardware |
| III | Programming and software development; "professional" knowledge |

These three types of technology knowledge are interesting, as they map onto learning structures, particularly in Blooms' revised taxonomy, respectively (Anderson et al., 2001; Krathwohl, 2002): the practical use basis of technologies maps onto the "remember", "understand" and "apply" levels; the understanding and fixing aspect maps onto the "analyse" level (and to some extent, "evaluate"); and finally the professional knowledge maps onto the "create" level. Figure 5.1.1 shows this diagramatically. The fact that this maps onto Bloom's revised taxonomy shouldn't be surprising, as the question I asked was about 'knowledge', which by definition should map onto these cognitive domain structures.

In Anderson et al.'s explanation of Bloom's revised taxonomy (Anderson et al., 2001), the authors also set out four types of knowledge more generally, described in Table 5.1.2.

**Figure 5.1.1**

*The cognitive process dimension of Bloom's Revised Taxonomy (Anderson et al., 2001) and the three types of technology knowledge*

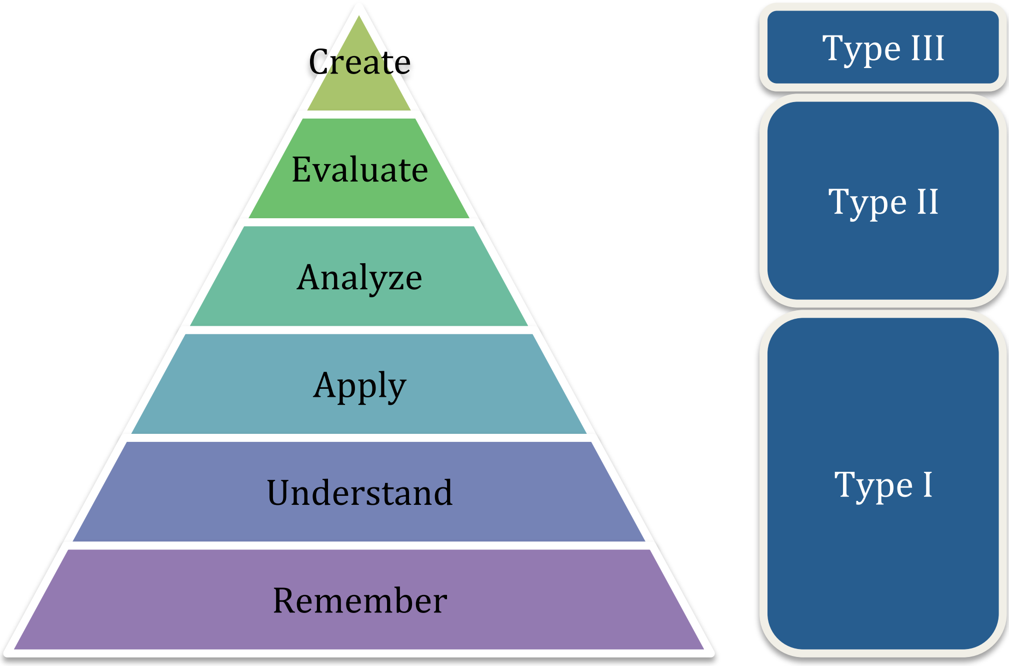



**Table 5.1.2**

*Types of knowledge (Anderson et al., 2001)*

| Type of knowledge | Description |
|---|---|
| Factual | Discrete, facts, terminology |
| Conceptual | Organisation, classification, theories, models |
| Procedural | Processes, skills, techniques, methods |
| Metacognitive | Self-awareness, self-knowledge, strategies about cognition |

**Table 5.1.3**

*A mapping of Anderson et al.'s (2001) types of knowledge onto types of technology knowledge, identified from participants' interviews*

<table>
<tr><th>Anderson et al.'s types of knowledge</th><th colspan="3">Interview participants' types of technology knowledge</th></tr>
<tr><td>Factual</td><td rowspan="2">Type I</td><td></td><td rowspan="2"></td></tr>
<tr><td>Conceptual</td><td rowspan="2">Type II</td></tr>
<tr><td>Procedural</td><td rowspan="2"></td><td>Type III</td></tr>
<tr><td>Metacognitive</td><td></td><td></td></tr>
</table>

Table 5.1.3 shows how each of the types of technology knowledge determined by my interview participants maps onto Anderson et al.'s (2001) types of knowledge. There is not a perfect mapping with each type of technology knowledge being of one type of general knowledge. Instead, there are overlaps in the categories. Type I technology knowledge covers both "factual" and "conceptual" knowledge, since the ability to use lots of different types of technology on a practical basis encompasses both the specific facts of how to use a given technology, but also elements of organisation and classification in having knowledge of different groups of technologies that is transferable. For example: using social media generally, as opposed to just knowing how to use Facebook or Twitter; or using computers generally, or even just those running MacOS, as opposed to just knowing how to use a 2011 MacBook Air laptop. Type II technology knowledge, which is about understanding, building and fixing technology, uses elements from both "conceptual" and "procedural" knowledge. It is "conceptual" in that it requires a knowledge of the underlying classifications and models in order to engage with hardware to build and fix it, while at the same time being "procedural" in that knowledge of the processes of a given technology is important in order to be able to understand the hardware. Kinchin et al. (2019) suggest that conceptual and procedural knowledge are constructed differently by students, and used differently as well depending on the context; this fits with my participants' three types of knowledge since the three types are independent of each other. Type III technology knowledge is the only one that does not overlap explicitly. Type III is about programming and software development which requires knowledge of the processes of computer software, and having the skills to use that.

Although Anderson et al.'s (2001) "metacognitive" knowledge was not expressly discussed by participants as a type of technology knowledge, it came through in the rest of the interviews: students assessed their own technology knowledge levels and the associated strengths and weaknesses; they considered their motivations for choosing to use specific technologies; Harris mentioned that he uses technology as a reward for doing other types of work; and students talked about how they chose to learn specific technologies for specific tasks. These self-regulatory behaviours were evident throughout all of the interviews. As Anderson et al. (2001) themselves point out, the "metacognitive" knowledge seems to overlap all other types of knowledge, and perhaps this was why it was not identified as a separate technology knowledge level by my participants.

## 5.2 Research Question One

> How do usage and attitudes to technology and technology-enhanced learning in higher education differ for students of different age groups?

The quantitative results from the questionnaire did not show a difference in overall attitude to technology between students of different age groups. Instead, the main difference seemed to be in how students of different ages used technology. The qualitative analysis did show some differences in attitudes, however. Both sets of results will be discussed in this section.

Overall, among my participants, mature students (aged 26 and over) used fewer technologies than younger, non-mature students. The mature students also used fewer technologies when they were doing activities related to their university courses, as opposed to non-course activities. Non-course activities are tasks and activities that students do outside their course – they may be activities for pleasure, or non-course-related learning, but done in students' personal time. For these non-course activities, the number of different technologies used by mature and non-mature students was no different. This means that students of all ages used the same number of technologies for personal activities. Since all ages of student are choosing to use technology, it is therefore clear that the hypothesis that mature students are scared of technology was not borne out by my study. My definition of 'mature' was students that were aged over 25, whereas some authors suggest that we may only see differences in broad technology use for older adults (Czaja & Sharit, 1998; Selwyn, 2004). If differences are only evident in older age groups, I should therefore have been able to observe a difference in the extent of personal use between the different age groups of mature students, with older age groups using technology significantly less. However, my results do not show a difference between any of the age groups, and therefore do not support these studies.

Ching et al. (2005) suggest that if a student chooses to use technology for their personal non-course activities, then their use will be equal across all aspects of a student's life. My results, however, show there is a difference in the number of technologies used between course and personal activities, and therefore is not in agreement with Ching et al. The difference between course and non-course technology use is clearly shown in my bar charts (Figures 4.2.1 – 4.2.3), showing the distribution of which technologies were chosen for each. Furthermore, discussions with my participants in interviews suggest that students' choices about which technologies they used are informed by a number of different things, one of which is purpose, so it therefore makes sense that course and non-course technologies are used differently. The survey open-text comments, particularly for the Utility theme, also seem to agree with this difference in technology choice.

Another factor that affects the choice of technologies is perceived competence; Hawthorn (2007) found that older students selectively choose technologies, actively limiting the tasks they do using technology to those that they know they can do without making mistakes. Although Hawthorn's research was carried out for students aged over 60, it may hold true for younger mature students as well. My results show that the mature students used fewer technologies for learning, and this may be due to students choosing the technologies with which they are most comfortable to carry out learning tasks. Learning tasks are usually considered important by students, with summative assessments being considered most important, followed by formative assessments, then least important are class preparation tasks (W. Lan, 2005). Task anxiety also increases with increasing task importance (Nie et al., 2011). Students may selectively use technologies they are comfortable with, and therefore less likely to encounter problems using, in order to carry out the most important tasks, which may in turn ameliorate their anxiety. Some of the open-text comments suggested that students found using technology in education was anxiety-inducing, and that may also result in avoidance of unfamiliar technologies, which is in agreement with Meuter et al. (2003). However, it is possible this anxiety is due to a lack of knowledge or understanding about the new technologies they were being asked to use, or perhaps that the technologies have changed through updates since the student last used them. The participants did seem to believe that this lack of knowledge can be addressed through specific training being given for these technologies and TEL.

In addition to differences in number of technologies used, the mature students also used technology overall less frequently than the non-mature students. It is possible that students who are older may be being more selective with which technology they are choosing, and when they are using it (Hawthorn, 2007). This may also cause them to be using fewer technologies, as mentioned earlier. Other factors that may affect the students' technology choice may be their stage of life or "life fit" (Selwyn, 2004, p. 378). For example, students who have families are more likely to attend university as mature students, and be more focussed on their family; they therefore may choose to reduce their own use of screen technologies, or at least the amount of time they spend using them, in order to set an example for their children (Jago et al., 2013). Alternatively, students who are focussed on their careers may be more likely to be younger; as part of building a career, they may be more likely to use technology to do so, therefore increasing the frequency of their technology use. Another possibility could be that mature students have more commitments such as family or jobs, and these may simply keep mature students busier (Estes, 2011), and since most of the technologies in my survey were recreational or work-related, being busy will reduce the time available to students, and thus reduce their frequency of use of these technologies. Older mature students may also work in careers that simply do not need as much technology use as careers that their younger counterparts choose. One of my interview participants was already retired, and returning to education for interest and fun, with the option for a career change. Adults who have retired, however, often feel pressure from their family members to use technology they may not necessarily want to use, as younger family want an easy way to keep in touch or assist their older relative (Selwyn, 2004). This may either increase technology use as they comply, or reduce technology use as they stubbornly do the opposite. In the future, it might be an interesting study to explore how technology use and types of technology in the workplace has changed over time, using a finer-grained time scale than the TAQ.

It is important that we do not interpret a lower frequency of use of technology as students avoiding technology and TEL. Based on the number of technologies used, this is not the case, and the mature students in fact seemed comfortable with technology. It is possible that the mature students, particularly with increasing age, are used to not having technology for specific tasks in their lives, and therefore simply don't feel the need to use technology themselves for those tasks. Some examples of tasks that we used to do without technology mentioned by participants were finding tradespeople, sending letters, locating unfamiliar buildings, and booking holidays; nowadays, however, many people find it easier to use the technology available to us. In my own experience, older people are more likely to gravitate towards the traditional ways of doing these tasks – using a yellow pages, sending paper-based letters, using a paper-based map, or going to the travel agent – often simply because that is the method they are most familiar with, and it would be more difficult to think about changing how they do it. This is supported by some of the open-text comments made by students, who said that pen-and-paper solutions are often easier for them, and technology can actually make their tasks harder.

Reducing the frequency of technology use may also be a conscious choice that mature students are making. It was clear from the participant interviews that students were wary of technology addiction, and this may be inflamed by the media. News articles often demonise technology (e.g. Manjoo, 2018), and popular television series such as 'Black Mirror' are heavily based around the risks of technology (Blanco-Herrero & Rodríguez-Contreras, 2019). These factors may induce students to try and reduce their technology use.

Studies suggest that frequency of technology use and amount of experience affect attitude (Czaja et al., 2006; Gardner et al., 1993). More frequent technology use and more experience usually manifests as a more positive attitude towards a particular technology, with the additional benefit of lowering anxiety levels. This should mean that students who use technology more frequently, i.e. the younger students, should have more positive attitudes towards it. However, my study did not support these findings, as it did not find a difference in attitudes between younger and older students.

Among my participants, the mature students have used technology for a longer period of time than younger students. There are a number of possible reasons for this difference. My survey included a wide range of technologies, some of which have existed for years, such as desktop computers or television. For the technologies that have been around for a long time, it may just be that the older students adopted them earlier simply due to the students' age. This may mean that although the mature students have been using the technologies for longer, they may have adopted them at the same relative age as the younger students. For example, an 18-year-old may have started using a desktop computer at the age of five years, whereas a 30-year-old may have also started using it at the age of five years; this would mean that the 30-year-old has used it for 12 years more than the 18-year-old. The effect of this is unclear, however. Many people learn to use a desktop computer (or other technology, but let us stay with this particular example for the moment) to a given required standard where it meets their needs. Perhaps this need was met at the age of 16 for both parties. The further 14 years of use for the 30-year-old may not therefore add further knowledge than they, or the 18-year-old, had at the age of 16. However, even if no new knowledge was created, perhaps familiarity and comfort with the medium did increase. Without further in-depth exploration, it is difficult to tell. A further explanation may be that some older mature students were 'early adopters' of older technologies (Ching et al., 2005), and instead of moving on to newer technologies, they didn't feel the need to upgrade. This may explain the difference in the number of technologies used by mature students and the overall length of time of that these technologies have been used for.

Although age differences were found for how many technologies were used, how frequently, and for what length of time, it is interesting that I did not find a difference between the overall attitude to technology between mature students and non-mature students. Additionally, neither of the two attitude dimensions of confidence and utility showed an age difference. This supports the findings of Czaja and Sharit (1998), although the participants in their study were non-student adults, but disagrees with Garland and Noyes (2005). These two contrasting studies were done 22 and 15 years ago respectively, however, and technology has greatly evolved since then, so it makes sense that technology usage has also changed. Moreover, those two studies were conducted seven years apart themselves, and in the early 2000s technology growth was rapid, which could account for the difference between their findings. If students of different ages don't actually have a difference in attitudes but do use technology differently, this may indicate that different groups of students use technology in a diverse manner unrelated to age.

Although the questionnaire results found no difference in attitudes, my interviews with students revealed some interesting differences across age groups. When aggregated across all of the interviews, students were generally more confident about actually using technology than learning about it. However, among the older students, the opposite was reported: they felt more confident learning about technology than using it. The older students were also generally more confident than younger students when using technologies that are new to them. There are a number of possible reasons for this. Firstly, older adults have lived through more years of technological innovations, and may therefore have had to learn new technologies frequently throughout their lives as the technologies have been adopted by their workplaces and society. Younger students won't have had this experience, or at least, not as extensively. Secondly, it may simply be a result of mature students approaching higher education from a deeper learning perspective than their younger counterparts (Howard & Davies, 2013). They may view learning new technology as something to integrate with academic concepts, and have a desire to understand, rather than viewing the technology use as something externally imposed or only necessary to complete a given task.

Participants talked about their depth of knowledge, and there was a difference in ages here too. Depth of knowledge links to types II (building, fixing hardware) and III (programming and software development) of technology knowledge. The younger students very much viewed learning technology as a skill for the future, whereas the older students viewed it as something they needed to know now. This initially seems in contrast to my earlier suggestion about mature students adopting a deeper learning approach, since needing to know something now suggests they are learning the technology as a task requirement. However, in my opinion, there is no conflict between these ideas, as they may just be occurring at different times. Mature students may simply be stating an urgency about learning each technology, since their course may be requiring them to use it immediately. This can then be followed by a longer period of slower, sustained engagement with the technology that is towards deep learning. In addition, younger students may simply be repeating the rhetoric about technology learning that they have been fed throughout their lives, that university is preparing them for jobs that don't exist yet (Universities UK, 2018), and it may not actually be how they approach technology learning.

There were some differences in attitude towards perceived-knowledge levels across the ages. All interview participants felt they were more knowledgeable than people older than them, suggesting that there is a perceived attitude that older people are less knowledgeable about technology, even amongst older people in higher education. Most participants felt they had similar knowledge levels to those in the same age group as them, including their friends (who, from participants' examples, seemed to be broadly in similar age groups to the participants). The main difference in how the participants viewed their knowledge level was when they were asked to compare their knowledge level to younger people. The 'younger generation' are often touted as the comparison point for technology knowledge, with many adults feeling like teens are all excellent with technology, exemplified by the idea of digital natives (Prensky, 2001). Although this has been debunked (P. A. Kirschner & De Bruyckere, 2017), the idea behind the digital native remains persistent in the minds of both researchers and the public (Thompson, 2013). It is therefore interesting to examine the views of HE students towards this. Around half of the participants felt that they knew less than younger people, while about a third felt that they knew more. Generally, older students viewed younger people, particularly children, as being capable with technology. The open-text comments from the questionnaire suggested that older students were also more concerned about their level of knowledge, even though the interviews showed they were generally more familiar than younger students with 'unusual' technologies such as NAS servers and the R programming language.

There was an interesting age divide when participants were asked to identify examples of technology they were confident with, enjoyed, etc. The older students were more inclined to tell me about technology that was hardware, whereas the younger students thought about technology as software, and this was also true for when students were asked to explain what the term "technology-enhanced learning" meant to them. This ties in with the three types of technology knowledge, where hardware knowledge falls under types I and II, whereas software can be types I and III. The difference between students of different ages identifying hardware and software may be due to a change in how we use the word "technology" and what is has come to mean. "Technology" in the past has indicated progress – not social change, but progress in tangible items; "technology" used to mean hardware, building better and smaller computers and chips. Nowadays, we don't see hardware as exciting and representing the future. This may be because with enough money, we can build computers and machines of nearly unlimited power, and hardware is therefore no longer the challenge. Instead, there is a vast untapped potential in software and processes such as machine learning and artificial intelligence, and that is where the future of computing and technology seems headed. With this in mind, it would make sense that the older students think of technology as hardware, and younger students think of software.

Another interesting finding that came out of the interviews is that, generally, the older students expressed that they did not like being perceived as being scared of technology. This is a view held simultaneously with thinking that they knew more about technology than people older than them, which may imply that they view older people as having more negative attitudes; interestingly, this is exactly the opinion that they don't want others to have of them! This may indicate a level of age-dissociation from the negative stereotype (D. Weiss & Lang, 2012). Older students may also be conflating others' perception of their fear with their competence, as older people are often considered to be less competent than younger people, even when the evidence suggests otherwise (McCann & Keaton, 2013; North & Fiske, 2015). Therefore they may react more strongly to the accusation of fear, on the basis that it is also an accusation of incompetence. Alternatively, it may simply be that mature students don't wish to feel judged. This is something that is often a sensitive issue for older students, who may already feel that they are putting themselves at risk by accessing higher education (Baxter & Britton, 2001).

Overall, since my study found no difference in technology and TEL attitudes between mature and non-mature students, this may indicate that mature students do not, contrary to the stereotype, fear technology. However, it is possible that this is a recent development, occurring since previous studies were completed, and that it may not be generalisable to the general population of lay adults. It may also be the case that new technologies are simply easier to use, and therefore evoke less negative attitudes.

It is important to point out that my results do not show that no students were anxious, or didn't have negative attitudes towards technology. Many students do have anxiety towards using technology, for various reasons, as shown in my interviews. Previous studies have shown that negative attitudes may be caused by negative experiences (Broady et al., 2010; Straub, 2009), and this is equally true of technology use, particularly in education. However, my results show that there is no one particular age group that had more negative attitudes or higher anxiety levels. When both educators and students in the higher education system begin to recognise and internalise this, it should help prevent perpetuation of the stereotype that mature students are scared of technology. It is important to reduce this stereotype, since it may affect how educators use technology for their courses with students who are mature. Some educators may avoid technology completely, or may make mature students feel patronised or self-conscious by singling them out or overexplaining. These actions may also be damaging to students, mature or otherwise, who do have anxiety about technology, as avoiding situations that cause anxiety can actually make anxiety worse (Stapinski et al., 2010). Therefore the onus is on educators to provide and encourage positive learning environments, which can then reduce anxiety (E. M. Marshall et al., 2017).

## 5.3 Research Question Two

> What factors affect students' use, attitudes and confidence with technology and TEL, and is there a difference between mature and non-mature students?

The questionnaire results did not show a difference in the attitudes (one dimension of which was confidence) towards technology and TEL between mature and non-mature students. However, it was found that the mature students did use technology differently: they used fewer technologies less frequently (although they have used them for a longer time). This may mean that they have different factors affecting their attitudes and confidence, even though the attitudes and confidence may be broadly the same.

Participants felt that having more perceived knowledge increased their confidence with technology and TEL, and led to more positive attitudes. Knowledge was linked to many different benefits, both directly related to technologies and TEL, and those more tangentially related. Participants felt that knowledge of certain technologies allowed them to apply that knowledge to learning other similar technologies. The Internet was also often stated as an excellent learning tool, and participants valued the Internet as something that could help them learn new technologies and TLEs, as well as course content, more easily. Structuring learning experiences so that students can apply concepts to new situations has long been a tenet of good pedagogy (e.g., Bloom's revised taxonomy (Anderson et al., 2001) and habits of mind (Alhamlan et al., 2018)), and it absolutely should be considered when educators are expecting students to learn new forms of technology and TEL. Therefore type I knowledge (knowledge of lots of different types of technology) is a vital part of scaffolding learning of new technologies. Most age groups mentioned the knowledge theme approximately equal numbers of times, with the exception of the 61-70 age group, who mentioned it more. This may be due to older students viewing knowledge, or at least type I knowledge, as a more important part of technology use, whereas younger people may view skills as more important.

Participants also perceived that having a higher level of knowledge allows them to stay safer online. Online safety was something mainly mentioned by the younger students, which is interesting since I would have expected the older students to be more worried (such as Aylen's parents being concerned about doing activities such as booking and buying online). One reason that younger people tended to be more worried could be that online safety is actually more of an acknowledged skill in the lives of younger students. Online safety is often taught explicitly in schools (Boulton et al., 2016; Department for Education, 2019), and has been compulsory in the UK from September 2020 (Department for Education, 2019). Perceptions of online safety threats can also arise from the media, whether through the news (Tsai et al., 2016) or entertainment – for example, Bill mentioned the series 'Black Mirror' which focusses on technology-based dystopias (Blanco-Herrero & Rodríguez-Contreras, 2019). Series such as

‘Black Mirror’ may be watched more by young people, particularly as young adults are the focus in the series (Blanco-Herrero & Rodríguez-Contreras, 2019), and people tend to watch television shows that are about characters who are the same age as themselves (Harwood, 1999). Media and school education therefore seem to alert younger people to online safety considerations more than older people, and this could be an explanation for my findings.

Some students expressed during their interviews that they enjoyed the challenge of learning new technologies. They felt their knowledge level changed over time, as their skills with technology constantly evolved and improved as they used them more. However, they also acknowledged that technology itself had changed over time, and they actually viewed that as a barrier to using technology. This may be due to feeling like they have been outpaced by technological advances, or that everything they learn is redundant shortly thereafter, which is demotivating. The evolution of technology might be considered more of a barrier for mature students who have seen technology change more, and who are perceived as less adaptable; however, several participants opined that mature students would be more adaptable to new technology due to having to adapt more frequently.

From my interviews, it is clear that having type I knowledge (using a range of technologies) can allow students to begin to recognise and learn the universal iconic language that is emerging across many modern technologies, and was identified as one of Foucault’s types of technologies (Nilson, 1998). Participants stated that this shared iconic language, which consists of icons such as the ‘hamburger menu’ and ‘account circle’, can help students navigate the frustration of learning new or complex technologies. My participants felt that complexity in a technology reduced their confidence and could increase the feeling of overload or being overwhelmed, so strategies to avoid this are important. The shared language icons provided users with a feeling of familiarity, and a starting point that they could understand. Another strategy to avoid overload is keeping the formatting and layout simple. Participants expressed a preference for mobile-friendly formats, as mobile formats tended to be simpler and less cluttered, as well as most of them integrating icons from the shared language. Unsurprisingly, participants were more confident with technologies that they found easier to use, whether physically or through user interface design; therefore, having these familiar icons from the shared language can mean a difference in attitudes and confidence for students of all ages.

Participants felt that technological understanding, particularly of knowledge types II (building, fixing hardware) and III (programming and software development), increases confidence. The older students had a tendency to think that younger people have grown up surrounded by technology, and therefore find it easy to use and are more confident, as shown by around half the participants feeling that younger people know more than them, and this may be reflective of Prenksy’s undue influence (Prensky, 2001). The older students may believe that the exposure younger people have to technology increases all three types of technology knowledge (I, II and III), and therefore confidence. However, the confidence attitude dimension did not differ for different age groups. Some studies (Czaja et al., 2006; Gardner et al., 1993) suggest that the frequency of use of technology is one of the factors that can increase confidence. However, it is my opinion that exposure to technology growing up only increases type I knowledge, which is knowing how to use different technologies. While type I knowledge may be picked up through exposure, types II and III knowledge usually require more effort. Students may have studied computing subjects at school, or done significant amounts of personal study or experimentation, to learn the aspects that fall under these knowledge types. Since computing courses tend to be optional, students who have done these will have done them of their own free choice; "freely-chosen" technology use has been found as more of a determinant in attitude than "required use" (Garland & Noyes, 2004, p. 834). Therefore the students who have knowledge types II and III are probably more familiar with technology generally, and therefore more confident.

Knowledge and exposure are subsets of experience. Authors often define 'technology experience' as frequency of use (Walls et al., 2010) or length of time of use (Yushau, 2006). However, Jones and Clark (1995) suggest experience consists of not only amount of use, but also the number of opportunities available, and diversity of use. The three types of knowledge are encapsulated in the idea of diverse use, with freely-chosen use coming under 'opportunities available' (B. Smith et al., 1999). Familiarity can describe whether a student has used a technology at all (Sam et al., 2005), or how much they have used it (Martín del Pozo et al., 2017), and is another subset of experience.

It was clear from conversations with participants that familiarity with technologies increased their confidence with them and led to a positive attitude. In contrast, having to use unfamiliar technologies could lower overall technology confidence and increase anxiety, particularly for the younger age groups. This is in agreement with the literature that experience with a technology or ownership of a particular technology can improve attitude towards it (Al-Emran et al., 2016; Jay & Willis, 1992; Samani et al., 2020).

In addition to increasing confidence, participants felt that being more familiar with a given technology could actually increase their interest and enjoyment of using it. This is in agreement with Christensen (2002), although their study was based on primary school children. The positive relationship between familiarity and enjoyment is something I have encountered in my own teaching experience. I use technologies such as Plickers (an audience response system) and Microsoft Excel in my classes, and my students often tell me that their enjoyment of using it has increased over time as they've become more familiar (and therefore more confident) with it. Some studies have found that enjoyment has strong significant relationships with perceived ease of use, attitude, and usage intention (Abdullah et al., 2016; Junghyo Lee et al., 2019). It is interesting that in their study, Lee et al. (2019) suggest that enjoyment drives the other factors, whereas interviews with my participants indicated the causation was the opposite way around, with enjoyment being driven. This difference may be due to a difference in focus; Lee at al.'s paper was about virtual reality entertainment amongst non-students, whereas my conversations were based around technology and technology-enhanced learning for students. Therefore, the primary reason for Lee at al.'s sample to use technology was enjoyment, whereas mine was education-related.

One may therefore assume that the reason for use is the driving factor in both cases.

Although familiarity caused an increase in enjoyment, participants also mentioned that if a technology is used too much, their enjoyment, interest, and attitude can decrease due to boredom with it. This means that some students find technologies that are new (to the student) or novel (new to the world) exciting and enjoyable once they get to grips with using it, but that technologies mustn't be overused. Enjoyment of technology is important, since if the student didn't enjoy a technology, their desire to learn it was lower; since technologies introduced in HE tend to be required for specific tasks or assessments, it is important that students learn them. This finding is in agreement with the literature which suggests that boredom demotivates students and creates negative attitudes to technology (Loderer et al., 2020). Additionally, the difficulty and complexity of a technology affected students' interest and enjoyment. From the interviews, it's clear that most participants (9 out of 11) do enjoy technology generally, and those who don't tended to be in the older age groups. However, most people (10 out 11), regardless of age, enjoy technology for learning. This is an interesting finding, since students will express displeasure at using specific technologies for learning, whereas they don't for personal use. This may just be a function of choice, and therefore when students are allowed to choose their own learning technologies, they are much more likely to enjoy them.

It is also possible that the purpose of a technology is the reason for enjoyment, 'Purpose' was the theme mentioned most by students, and seems to be the main reason they choose a technology. The analysis of the open-text comments also supports this, as the 'Usefulness' code in the Utility theme may also be called 'Purpose'. Whether a technology is suitable for a given purpose seems to be the main driving force behind whether the student feels confident or not with the technology, as most participants said they were more confident with technologies that are fit for purpose. Different technologies are available for different circumstances, depending on the task and the location, and my participants took this into account by only choosing technologies that they thought were useful and practical (or at least, thought that they should choose these). It is clear that some students only used technology when absolutely necessary, and this is an extreme example of choosing technology based on purpose. Sun et al. (2016) suggest that students can be "mindful adopters" (p. 3) of technology, where they consider the functionality and novelty of the technology, as well as how it fits their needs, and how it compares with alternatives. This mindful adoption positively affects their perception of the fit of the technology to a given task, which then influences how useful they perceive the technology to be, and their attitude towards it. Sun et al. (2016) therefore supports my findings that students consider purpose as a major factor in choosing technology. Similarly, if a technology isn't necessary, or isn't better than an analogue paper-based version, students will choose the one that makes their life easier, which may the one that requires the least effort, or that they are most familiar with. Arts and humanities students especially put more emphasis on the physicality of the medium they were using, which often led them to choose analogue rather than technological solutions. This is in contrast with students who were on degrees in the sciences and social sciences, who were more likely to think technology was the more useful option over analogue solutions. Guidry and BrckaLorenz (2010) looked at the use of academic technologies across disciplines, and found that the arts and humanities (and engineering) disciplines used technology the least, both for student and faculty use, and this has been supported by my findings.

Specific purposes that participants mentioned in the interviews that they want to use technology for included: receiving instant formative feedback from lecturers; improving accessibility for students with learning disabilities; accessing specialised equipment and software; maintaining relationships and friendships; improving learning and providing study support, for example through access to additional resources and explanation outside the lecture; enabling group learning; and as a fun reward for getting work done. Most of these purposes are work-related, and the idea of communication is a common thread throughout several of these purposes.

In terms of communication, the replacement of face-to-face interaction, both for teaching and in relationships is interesting. Several students viewed it as a good thing as it made communicating easier, but several other students thought that technology actually makes us less sociable. There are probably several factors that affect whether a student perceives the replacement as positive or negative. It may depend on the type of face-to-face experience that is being replaced, whether it is social (e.g. chatting in the pub), organisational (e.g. arranging to meet somewhere), or educational (e.g. seminars). For educational purposes, it may depend on an individual's learning preferences, such as whether independent or collaborative study is preferred (Balakrishnan & Gan, 2016). It may also depend on how introverted or extroverted the individual is, particularly surrounding social interaction. Introverts tend to prefer online asynchronous communication and developing an online identity, whereas extroverts tend to feel inhibited by online factors and prefer synchronous face-to-face communication (Balakrishnan & Gan, 2016; Orchard & Fullwood, 2010). This suggests that introversion or extroversion as a characteristic may influence students' preferences towards online communication, with introverted students tending towards more positive attitudes and confidence. In an interesting example, the oldest participant labelled himself as "gregarious" (Felix), which would indicate he views himself as an extrovert. Felix mentioned 'Purpose' the fewest number of times, and talked about refusing to have a mobile phone. He frequently mentioned he preferred face-to-face interaction, so this would seem to be consistent with the literature. There are therefore two possibilities to consider with Felix as to why he prefers face-to-face over using technology for communication. Firstly, this may be due to his extroversion. Alternatively, he may prefer face-to-face since much older students may prefer to avoid using technology for communication purposes. However, for this second point, I am not comfortable drawing this conclusion since the samples sizes are so small for the older student age groups.

In addition to technology fulfilling a specific purpose, the participants often commented that technology can make their lives more convenient, by saving them time and effort. Time and effort were also the primary types of convenience found by Mitzner at al. (2010). If a student encounters a technology that does help them in their everyday life, they are more likely to continue using the technology; since they will use it frequently, they will be less likely to view it as scary, and will view it more as a utensil, thus becoming more confident with it. In contrast, however, when technologies are deemed inconvenient by taking more time or effort to use, that leads to negative attitudes. The students I interviewed were generally more apprehensive about technologies until the way it affected them and their lives was clear. This is in agreement with Mitzner et al. (2010) who found that convenience was one of the top three benefits considered when adults aged 65 and over were choosing technology. Additionally, when people are used to their lives being more convenient in one medium, they also expect that convenience to be carried across to other media (Dekimpe et al., 2020); this is not always optimal, particularly if a new technology is being introduced in the classroom, since savings in time and effort don't necessarily apply in the initial learning phase of a new technology (Russell, 1995). However, once the learning phase has been completed, then students can reap the benefits of convenience.

There was little difference between the age groups in how often they mentioned convenience. This may be unsurprising, because a technology either increases convenience or it doesn't; however, it may also be based on how familiar students are with the stated technology. Since students in the interviews tended to bring up convenient technologies during the discussion about convenience (as opposed to inconvenient ones), it is probably safe to assume they are confident and comfortable with the technologies mentioned, hence the lack of difference.

From the interviews, I found a number of barriers to students being confident with technology and TEL, resulting in them choosing not to use it. One of the barriers was difficulty, as mentioned earlier. If a technology is difficult to use and takes a lot of effort, the student's confidence is reduced, and they are likely to stop using it. This makes the technology inconvenient for regular usage (Mitzner et al., 2010). Another demotivating factor was if a technology was perceived as unreliable or outdated; the students were reluctant to attempt to use technologies that they viewed as redundant or nonfunctional, both for work and personal use (Mitzner et al., 2010). This is particularly important in university courses, as students are very aware of how their lecturers and tutors use technology. Both my interviews and other studies have found that students feel that it is the role of the lecturer to be competent using the technology, as well as being able to support students' use (Khoo et al., 2010). If a technology is not being utilised well, it will negatively affect students' attitudes towards it. There are a number of things that affected whether a student viewed a technology as well-utilised, as found from my interviews. The most obvious is the lecturer's skill in using the technology, which is again in agreement with the literature (Maclaren et al., 2017). This is the first thing a student sees, and if the student feels the lecturer is failing to use a piece of technology, they will have little patience with both the lecturer and the technology. This in turn leads to a negative attitude towards the technology, exemplified by Harris' comments. It is therefore important that lecturers choose the technologies they are asking students to use carefully. If participants were being forced to use a particular technology, they began to feel resentment if they thought the technology wasn't very good, or if it wasn't being used well. This is important on an institutional level as well, as different universities have different policies on using virtual learning environments and integrating TEL opportunities into teaching practices, as seen in the literature review section on University Learning and Teaching Strategies.

Another barrier that participants mentioned to choosing to use technology, and therefore increasing confidence with it, is the cost of technology. This is something that was particularly mentioned by the older students, who tended to explicitly avoid more expensive, newer technologies as they viewed them as more fragile and likely to break. This meant that confidence with them tended to be lower, as students felt like they couldn't use the technology frequently or experiment with it, due to fear of breaking it. In contrast, some students mentioned that the expensive technologies are generally longer-lasting than their cheaper counterparts, as long as the user didn't break them. If an expensive technology breaks, it is more likely to be broken by the user (or their cats, in Julie's case) than for the technology to wear out by itself.

A further barrier to technology confidence mentioned by participants is the societal view of technology. The media can portray frequent use of technology as addiction (e,g, Manjoo, 2018). The accusation of technology addiction is often directed towards younger people and students, and therefore students may feel a pressure to avoid using certain technologies in order to avoid succumbing to this addiction. Several participants mentioned the idea of technology addiction, and actively tried to avoid it. Ricciardelli et al. (2020) found that 50% of students on a social-work course worried they spent too much time using social media, with 71% of students thinking that others spent too much time on social media, and 69% feeling that internet addiction should be classified as a mental disorder. This suggests that students have a tendency to judge others as being on social media more than themselves, or at least that it is more of a problem for other people. From my interviews, some students felt like technology such as social media can be particularly invasive, and feel judged through it. Nearly half of students in Ricciardelli et al.'s study felt that they had had negative experiences on social media (Ricciardelli et al., 2020). Negative experiences lead to negative attitudes and therefore students who have had bad social media interactions are less likely to use it or be confident with it. This is a problem since social media has become a part of teaching in HE, and is often lauded as a useful form of technology for communication or dissemination (Stathopoulou et al., 2019; Tess, 2013).

Some technologies, particularly mobile technologies, were also avoided by my participants as they felt they were too pervasive and distracting in everyday life, resulting in phenomena such as 'phubbing' (looking at a smartphone during a real-life conversation) (Al-Saggaf et al., 2019). The presence of mobile phones made some students feel like they are missing out on face-to-face interaction. This may carry over to the classroom as well, with students potentially resenting technologies that they feel interrupt the types of learning they prefer, such as face-to-face teaching or group discussion.

Technology anxiety affects students of all ages, but among my participants, there were some age differences in *when* it affects students. The older participants stated that they were more likely to feel anxiety before using a particular technology (anticipatory anxiety), whereas the younger participants were more likely to be anxious during the process of using it. No one said they felt anxious *after* doing a technology-based task, which supports Czaja and Sharit's (Czaja & Sharit, 1998) finding that people feel more comfortable with a given technology after completing a task using it. From my interviews, younger participants often felt a fear of doing something wrong, particularly if they found the technology complicated. The older students feeling anxiety beforehand, however, may just be a fear of the unknown. In both of these cases, students may find training in using a particular technology useful.

The quantitative results found that younger students were more likely to feel they needed more training to use technology. In contrast, open-text comments from the questionnaire indicated that it was the older students who felt they wanted more support and training to use technology. In the interviews, however, there was no difference between the age groups for whether they wanted support generally, with students from all age groups saying they wanted it. Therefore, with the three different methods of data generation all giving completely different results, it is difficult to come to any conclusions. One explanation could be that it is in fact the younger students who want more support, since the survey had the largest sample size and were more likely to be a mix of all confidence levels; however, the younger students who volunteered to be interviewed may actually be more confident with technology than average, resulting in no difference being apparent from the interviews. Additionally, the older students who left questionnaire comments may have been particularly under-confident, and chose the open-text box as a method to express that.

Among my participants, when students of any age sought support, they usually initially used the Internet, by Googling problems or seeking answers on message boards. If they were unable to solve the problem themselves using the Internet, they would then approach real life sources, whether friends, tutors, or university-provided IT support. This is in agreement with Liyana and Noorhidawati's findings (2017). The Internet could have been the first source of support since it is more instantaneous than in-person support, and convenience and time-saving are important considerations when students are seeking information (Connaway et al., 2011). The Internet allows you to find an answer within just a few minutes, depending on how adept at using search engines you are, but real life sources tend to take time. Asking your friends may take a few minutes, or it may take an hour. Some participants mentioned IT services taking a very long time to respond. Participants may have felt comforted knowing that in-person support was available, but were willing to invest a few minutes trying to solve the problem by themselves first.

It was clear from my interviews that familiarity also has a bearing on how one seeks support. The more familiar a student is with a technology, the more likely they are to attempt to fix it by themselves, since they are more likely to know the specific terms to search for, what's relevant and what isn't, and to put the effort into doing so (Khosrowjerdi & Iranshahi, 2011; Liyana & Noorhidawati, 2017). Having said that, even amongst graduate Computer Science students, only about three quarters of them felt they could often formulate appropriate queries related to their subject-specific problems (Liyana & Noorhidawati, 2017). If the problem is with a technology that a student is less familiar with, they may feel that they just don't know how to get started with searching for a solution. My participants stated that finding one's own solutions using the Internet or other 'self-support' situations such as trial and error also gave them a feeling of ownership over their own learning of technology; it was interesting that the mature students in particular were the ones who noticed this. This may be due to mature students tending to adopt a deeper learning approach (Howard & Davies, 2013), both to technology learning as well as academic content, and therefore the desire to understand for themselves may be more important to mature students.

Overall, there are many factors that affect students' attitudes and confidence to technology and TEL, and these may affect students of different ages in different ways. There is likely to be diversity in attitudes and confidence across groups of students, and it is therefore important for educators to identify the kinds of support needed in the particular age groups being taught.

## 5.4 Research Question Three

> What are the implications for the design of age-inclusive learning environments in higher education?

### 5.4.1 The Learning Environment

The findings to research questions one and two suggest a number of implications for the design of age-inclusive learning environments in higher education. The term "learning environment" can be interpreted to mean two things: an online virtual learning environment (VLE) such as Blackboard, Canvas, and Moodle, or the overall atmosphere and approaches to pedagogy taken by an educator, their department, or their university. Although I initially set out to draw up some design criteria for creating resources, during the course of this project it has become apparent to me that the surrounding learning environment, in both senses of the term, is as critical a part of higher education as any single set of resources. Therefore this discussion will encompass a broader set of foci than just web-based learning resources.

Since no difference was found in the overall attitude towards technology and TEL between mature and non-mature students, we can assume that among my participants, mature students do not have a fear of technology, or at least no more than their younger counterparts. In fact, the mature students I interviewed specifically disliked the idea of being considered "scared" of technology. The main difference between the different ages seemed to be in how students use technology.

During my interviews, students of all ages expressed some form of anxiety about using technology, particularly if they weren't experienced in what they were being asked to use. Therefore, when educators are designing learning activities and resources, we should not be considering age factors as such, but perhaps we should be thinking more explicitly about students who use technology less often. This often correlates with mature students, who used technology less frequently, and may take longer to reach the same level of comfort as those who use it more frequently (Rogers et al., 1998). Low frequency of technology use and low familiarity causes anxiety more than age factors. As well as affecting mature students, many of the younger students also used technology less often than we may expect. This may mean that the younger less-frequent users also need longer to get used to new forms of technology. This is exemplified by the open-text comments of participant 1, a non-mature student, who finds technology used for education overwhelming. When we are thinking about how to support students in their technology use, therefore, we should consider students, not by age, but by how frequently they use technology.

New technologies should be assessed by educators before use, making sure that they are accessible to all students, as this was a barrier mentioned by my participants. Educators have a responsibility to have basic skills in the use of any technology they introduce into the classroom, and need to have an awareness of when that technology can be successfully used, and its constraints (Khoo et al., 2010). Once this is assessed, then they can be carefully introduced into classrooms, with pilots to test acceptance and performance as necessary (de Freitas et al., 2006). Both purposeful use and accessibility require prior and ongoing diagnostic assessment with the students being taught.

With new technology, it is also important to consider whether training is necessary. Educators may feel that some technologies require little more than a brief explanation in class, but it is clear from my results that students will be approaching the technology with a range of different knowledge levels about the technology, and also a range of different confidences. Therefore it is worth offering training opportunities to students. These should not be compulsory, since in my experience, students who are forced to attend a class teaching them something they already know tend to build resentment, and this was agreed by students in the interviews as well. Optional training sessions will be useful for students who are less confident or who are new to a technology, whilst not wasting the time of those who are already familiar with it. The format, length and frequency of these sessions will vary depending on both the technology itself and the cohort. Students may not need support sessions on 'general' technologies such as computers and laptops, but if they are being asked to use specific software such as SPSS or Excel, or even a VLE, training may well be required.

The students in this study highly valued convenience as a property of technology and TLEs. They were much more likely to choose to use technologies that saved them time and effort (Mitzner et al., 2010). They stated that convenience in their learning environments can certainly be increased by using technology over face-to-face methods, by allowing students' educational activities to be flexible in both time and place. Technology allows fast and efficient access to learning resources and learning environments; if a technology is available at any time, it means that learning and leisure are too. From the interviews, it is clear that this is particularly important to students who have other life commitments, such as jobs, caring responsibilities, or longer commutes, and mature students are more likely to fall into this category (McGivney, 2004). These students may be trying to squeeze a short learning period into a very busy day. Students have mentioned to me in the classroom that they can only find time to work on university work after they have put their children to bed, which can be as late as ten or eleven at night.

Participants also valued technology that saves time on tasks such as communication. Traditionally, students would be expected to attend a lecturer's office hours to ask for help with problems. If they are studying late at night, or even if they just have incompatible schedules due to class timetabling, this means that attending an office hour can be impossible (Briody et al., 2019). My participants recognised that being able to contact a lecturer through technology means that students and lecturers don't have to physically wait for each other to be available, so communication is faster. Additionally, the students felt that it is potentially more efficient, as they can spend the time crafting the question they actually want to ask, in an email for example, rather than feeling rushed when 'grabbing' a lecturer for a quick chat after class.

From both my interviews and teaching experience, it has become clear to me that having convenient asynchronous learning environments and methods of communication is very important. This became particularly apparent during the March 2020 COVID-19 lockdown, where face-to-face classes were rapidly 'pivoted' online, and students and staff were both asked to participate in classes from home (Watermeyer et al., 2020). The lockdown created an increase in the number of students who were suddenly unable to work at normal times. Some were having to juggle their university course with home-schooling their children or working in key areas, while others were struggling with mental health due to losing their jobs, or living alone with no contact with other humans. This meant that students were often studying and emailing me far more frequently, and at hours even stranger than usual. Having rapid communication with me and student support services within the department was absolutely necessary during this time, particularly for mature students who were more affected by these problems (McGivney, 2004).

Access to technology has increased in recent years, although in the interviews, participants did recognise than technology is not ubiquitous, and access may be difficult. Even in Europe, which is widely considered a developed set of countries, only 87.7% of the population had access to the Internet in 2020 (Bozkurt et al., 2020). This was something else that became apparent during the March 2020 COVID-19 lockdown. I would estimate around 5% of my students did not have a working computer, internet connectivity, or both. This wasn't apparent during the normal academic year since these students were able to use technology provided by the university, such as computer suites in the libraries. My university took over a month to provide technology support to these students in the form of IT support to help them fix broken equipment, an internet dongle, or in many cases, a £400 grant for equipment. While it is good that the university provided this, taking four to five weeks to do so in a course where there are only 24 teaching weeks is a long time. This will have affected learner confidence with the material, as they will have had less time to study it than other students, and would have felt that they had to catch up quickly. Additionally, these students were being expected to learn new pieces of technology (e.g. internet dongles or new laptops) at very short notice in order to continue participating in their degrees. The lockdown exposed differences in students' access to technology, and this is definitely something that educators have to consider going forwards, particularly as the 2020-21 academic year is being conducted fully or partially online.

### 5.4.2 Design Criteria

Throughout the interviews, there were several design criteria that participants mentioned that they found important for learning resources and other learning environments. Many of these criteria are good principles generally, but this section will discuss them in terms of age inclusivity. These are particularly germane for the current academic year, since many educators in HE have been primarily teaching using online learning and learning technologies.

When teaching concepts or processes, students felt that resources need to be presented in small steps, so that they can easily recognise how one step develops into the next. This is in agreement with the idea of scaffolding, and also cognitive load theory (Sweller et al., 2019; Wood et al., 1976). This is particularly important for online learning where students may not have a knowledgeable party to assist them in taking those steps (as per Wood et al.'s (1976) definition of scaffolding). Students also felt that the pacing is important, with small steps maintaining a momentum while not going too fast. Pacing is important in individual resources such as slides or videos, but also in an entire instructional course, and has been widely discussed over the decades (Patel et al., 2018; Polly, 2011; Tincani & De Mers, 2016). A well-paced, well-scaffolded resource or learning environment allows for steady progression, although it is worth being aware that non-linear curricula may have different pacing rules (Patel et al., 2018). If possible, it is best to give learners control over the pacing of an instructional resource (Hsu, 2020; Petko et al., 2020), and this was something valued particularly by Gwen; she felt that the feeling of steady progression and control was important for her. I believe it is also important for age-inclusivity, since mature and part-time students will be less likely to leave HE if they feel satisfied with their progression and performance (Bolam & Dodgson, 2003), and allowing students ownership of their own progression can achieve this. Having control over their learning may also increase students' self-esteem, and this may particularly benefit mature students who tend to have lower self-esteem generally (Chapman, 2017; Tett et al., 2012; Young, 2000), something that I have noticed in my teaching. Three of my mature participants stated in their interviews that their confidence, not just with technology but more generally, started out very low at the start of the year, and increased as they progressed. It is possible that this increase can be expedited through designing learning environments so that students can learn to take ownership of their own learning.

Participants also felt that clear instructions are important. Instructions are the first step of communication between learners and educators in a technologically-enhanced environment, and from there students can ask questions that the educator can use to assess students' learning needs. This is in agreement with Martin and Bolliger (2018), who found that clear instructions and guidelines were one of the top strategies valued by students in online learning, and Smidt et al. (2017) who found that students thought clarity was the most important quality indicator for online courses. Clear instructions may also help mature students overcome feelings of inadequacy by setting out expectations in a way that is easy to judge if they have been met.

According to my participants, technology enables rapid communication between learners and educators, and there needs to be additional communication opportunities built into learning environments and instructional design to allow for instructions to be clarified, rather than 'leaving students to it'. Smidt et al. (2017) found that teaching faculty viewed communication and interaction as the top indicator of quality for online courses; interestingly, in that study students rated it significantly lower, which is also different to the findings of Martin and Bolliger (2018), who found that students rated online discussions highly. Perhaps the type of communication, interaction and discussion is the deciding factor. Although both of these studies were conducted in the USA, it is very likely that each asked different cohorts of students, and therefore the students would have had different experiences of online communication, which may have influenced the level of importance. Communication and discussion through technology may also help students to feel less isolated, something that particularly affects mature students (Baxter & Britton, 2001), which was clear from my interviews.

As well as interaction, the interviewed students found interactivity useful and enjoyable; they particularly enjoyed opportunities to test themselves on content through questions and quizzes. They also considered videos more interactive than written resources, perhaps because there is a voice (and sometimes a face) behind the material, which adds a layer of humanity and makes it feel less clinical (D. Marshall et al., 2020). This may also allow students to identify with the person behind the camera, which has learning benefits in itself such as maintaining attention, immersion, and deeper processing (Hefter et al., 2019). It may also be because video is a more natural medium than writing, or that it includes both audio and visual which enables greater processing capacity (Hefter et al., 2019). This will particularly benefit older students who may have reduced working memory capacity as they age (van Gerven et al., 2002).

The actual design of the resource was also identified as important by participants. My interviews showed that students often choose or reject technology due to its design. The students felt that well-designed resources should be easy to use, ideally with a centralised hub where they can access everything. Simple designs usually adhere to the rules surrounding the 'shared language', and this also makes them intuitive for new users, something valued by students (Smidt et al., 2017). Where the use of the shared language is not possible in resources, simply hosting them on a centralised system like a VLE may provide the framework for the shared language. However, it is also important that educators are aware that languages change and evolve, and the language of technology perhaps does so faster than others. Therefore we must ensure that if we are using the language in our learning environments, we are using the most up to date version.

Being simple and intuitive is important since it reduces cognitive workload for students when navigating the resource, allowing them to use that headspace better to learn the concepts being taught rather than being focussed on navigating the technology. This is particularly important for age-inclusive resources, since working memory and processing speed decrease with age (Paas et al., 2001; van Gerven et al., 2002). Resources need to be designed with the cognitive load in mind (Mayer & Moreno, 2003; Sweller et al., 2019). The inclusion of customisability in a resource or learning environment can both circumvent design problems and attract users, by allowing students to personalise it to what is useful for them, which is a criterion they value.

The option for students to choose a technology from a range of technologies, or to opt out of a particular technology is important. Students should be able to reject technologies, or at least minimise their use, where they feel the design is inhibiting their engagement with the actual content, and this will be particularly useful for lower-frequency users such as mature students. I would recommend offering a choice of technology, since from my interviews it is clear that the students do not like to admit that they are struggling with a particular technology.

### 5.4.3 Educators and Our Use of Technology and TEL Environments

Although the design of age-inclusive resources is very important, the actual use of the resources is equally as important to consider (Hammoud et al., 2008), and this came through clearly during my interviews. Therefore, educators' use of learning technologies and technology-enhanced learning environments needs to be critically assessed.

From the interviews, I found that educators' attitudes towards learning technologies affects students' attitudes, and this finding is supported by the literature (P.-C. Sun et al., 2008). As educators, we need to encourage positive learning environments, as well as positive attitudes to the chosen technologies. Modelling a positive attitude is difficult when the educator isn't positive, so the educator being comfortable with the technology and understanding its benefits is vital. This will work best when lecturers are allowed to choose which technologies they use for their teaching. Many departments and universities force lecturers to use certain technologies (O'Callaghan et al., 2017; Shelton, 2014), particularly with the technology focus in universities' Learning and

Teaching Strategies that I explored in my literature review. Even critics of learning technology acknowledge that the "core stakeholders", i.e. lecturers and students, must be involved in the process of choosing technologies for them to have a chance to work (Njenga & Fourie, 2010, p. 203). When educators are forced to use specific technologies that they are not comfortable with, students will be able to detect that negative attitude, and feel less comfortable with the technology themselves, and this is evident from my interviews. In contrast, if an educator is positive about the technology they are using, then student anxiety and negative attitudes will be reduced. This is something that I have noticed throughout all of my teaching – the technologies that are wholeheartedly supported by tutors are generally accepted and praised by the student body.

In addition to being supportive and positive, it is important that lecturers don't avoid using technology for their courses, since it offers a wide range of advantages. Participants, particularly Harris, stated that it is also important that educators don't just use technology for the sake of it, or only to meet institutional expectations. As with all tasks and resources, the technologies used for teaching should be pedagogically informed, with appropriate support and facilitation from the instructor. This is in agreement with Khoo et al. (2010), who also suggest that the educator must be approachable so that students can access this support. From my own teaching evaluations, informal student comments, and my research interviews, I have found that approachability is something that students value highly, particularly mature students. In a technology-enhanced classroom, this becomes even more important, since often the educator is the only one who can give advice and support to students about the technology.

Educators should have clear managerial skills in the classroom in order to maintain a dialogue with students about their technology use. From my interviews, I found that participants valued having a course laid out to them that could be clearly followed. The structure of the course should therefore be transparent. Since students in my interviews worried about the frequency with which they use technology, and mature students use technology less frequently, expectations for how often students are expected to use technology for tasks should be negotiated – for example, whether students are expected to check their emails every day, or whether they will need to bring their own technology to participate fully in lessons. This communication about the technology requirements of a course is important to ensure that students have enough time for the necessary preparations, particularly if they include using technology for assessment and feedback. Preparations may include procuring the necessary technologies (for example, smartphones for quizzes or scanning exam papers), beginning to learn the technologies they aren't already familiar with, or finding alternative arrangements. This should be accompanied by the course leader providing guidelines for participation, and also modelling good communication, one of the benefits of educational technology that is used in HE. These arrangements are in agreement with Khoo et al.'s (2010) responsibilities for online teachers. It is also important to realise that, based on comments from my participants, not all students will be able to learn unfamiliar technologies at the same pace, so lecturers should not expect that. Instead, we need to build time into our lessons and classes to allow students who use technology less often, such as mature students, to become more fluent with it gradually. Building in this learning time will also extend to broader timetable and curriculum design, where time should be set aside for teaching new technologies, particularly if the technology will be used for summative assessments. This may include offering additional 'beginners' sessions for these students outside of the normal teaching timetable. Enabling students to have this crucial learning time separate from their content lessons will also prevent cognitive overload (T. Clarke et al., 2005; Sweller et al., 2019).

In order to determine the technological learning needs of different groups of students, and in this case, students of different ages and usage patterns, educators should adopt diagnostic assessment. Diagnostic assessment has long been a useful tool in education, as it helps educators to identify the learning needs and kinds of support each group of students needs, the results from which can be used to decide the best instruments and teaching processes (Soeharto et al., 2019; Taslidere, 2016). Diagnostic assessment is frequently underused, particularly in classrooms where teaching may still be viewed as a 'transmission of knowledge' (J. Chen & Brown, 2016; Lehesvuori et al., 2018). This unfortunately often applies to lectures within the HE environment, where student numbers are large (Schmidt et al., 2015). The diagnostic assessment of learning needs is instead compatible with student-centred constructivist education, as it explicitly takes into account previous knowledge and conceptions of learning technologies. There is an opportunity here for educators in HE to embrace and embed the assessment of students' learning needs across all educational programmes, whether for learning technologies or other subjects.

## 5.5 Limitations

Although this study succeeded in generating rich and informative quantitative and qualitative data, it inevitably has some limitations. The study was set within a UK-based Russell Group institution, and therefore may not be generalisable to other nations or societies, or even other non-Russell Group institutions within the UK. Societies where technology is harder to access may be particularly unrepresented. Having said that, my participants were internationally diverse, and the issue of technology access in their home countries did not come up. This may indicate that students who have chosen to study abroad in the UK did not struggle with technology in their home country, especially as they would have had to apply online to attend the university.

Although sufficient for the study, the sample sizes are relatively small. Some of the age groups, particularly for the older students, have very small samples for the questionnaire, and even smaller for the interviews. This is reflective of the fact that there are fewer older students in the HE institution than younger students, and the numbers decrease as age increases. However, this will have affected the results, and perhaps masked some of the effects that may have otherwise been found between the older age groups. This small sample size may also have masked a digital divide between the older age groups, which may explain the difference in findings between this and previous studies, e.g. Czaja et al. (2006).

Participants were recruited via email. This may have affected the sample since the study was looking at student attitudes to technology, and students who are less confident with technology may check their emails less frequently, or be less likely to do online questionnaires (Vehovar & Manfreda, 2008). Although I chose not to offer paper copies of the survey since the invitation to participate was administered by email anyway, there may be a large selection bias towards students who are comfortable with their emails and completing online surveys. I tried to reduce this by keeping the survey open for three weeks so that students who didn't check their emails often would have the opportunity to see it, but those who are more uncomfortable with technology may have skipped over the mailing-list-style email, or perhaps not seen it, or not been prepared to go offsite to SurveyMonkey. In addition, the survey included an open-ended comment section at the end where I hoped to gain some useful information from those who would not volunteer to be interviewed. Those answering the open-ended question are probably not representative of the sample, let alone the population, due to non-response bias (O'Cathain & Thomas, 2004) and self-selection bias (Costigan & Cox, 2001).

There may also be a self-selection bias in the students who volunteered to be interviewed. Self-selection bias is impossible to avoid in research involving interviews since it is ethically integral that the interviewees are volunteers; however, as researchers we must be aware of the possibility of bias and what impact it may have (Robinson, 2014).

This study endeavoured to compare the attitudes towards and use of technology and TEL between mature and non-mature students. One of the drawbacks of the study that is not possible to overcome is that a mature status is only one aspect of a complex series of labels one can apply to a student. In addition to age effects, other qualities that may affect the study include gender, socioeconomic background, cultural background, and whether they are from rural or urban areas (Kennedy et al., 2010). These factors will have their own effects on attitude and use of technology. Further work in this area could attempt to normalise for some of these variables, but that would inevitably require larger populations from which to sample.

## 5.6 Further Work

Further research directly following on from this study could include running qualitative focus groups to allow participants to expand upon their individual interview answers. This has the advantages of allowing participants to "jog each other's memories" in a more relaxed atmosphere (Wellington, 2000, p. 81), and some interesting analysis could be made of the discussion between participants.

Three types of technology knowledge were found from the interviews with participants in this study. Further qualitative research could be done to explore these in more detail, perhaps by including questions on these types of knowledge in future interviews with participants. This could provide more robust data on the types of knowledge, as well as expanding or clarifying their definitions.

Further building on this study, I could involve participants from a range of different types of institution from across the UK, e.g. Russell Group universities, non-Russell Group pre-1992 universities, post-1992 universities, HE colleges and Further Education (FE) colleges offering degrees. It would be especially interesting to compare technology attitudes in the last two of these institution types, for two reasons: typically, colleges offering HE provision have higher proportions of widening participation students, who may have lower levels of access to technology; and colleges have historically been slower to adapt to using TLEs (Browne et al., 2006). It would also be interesting to carry out an international comparison of students from HE institutions in countries and societies that do not have the same widespread access to technology that we enjoy in the UK.

It might be an interesting study to explore how technology use and types of technology in the workplace have changed over time. This may have effects on students who have been in the workplace and then returned to university. Perhaps it will also affect degree and module choice made by students who are thinking of going into particular fields, as they may consider careers that are more or less technologically-focussed.

In the future, an observational study of students using technology and TLEs in a live classroom might also reveal whether their actual use reflects their attitudes. There may be opportunities to see what real difficulties they encounter, both generally and with specific technologies. This would perhaps allow educators to choose the technology they employ in their classroom more effectively.

Finally, it would be interesting to explore the implications of this study in relation to flipped learning curricula. ‘Flipped learning’ is where the ‘teaching’ and ‘homework’ components of a lesson are switched; typically, students access learning materials before the class, then class time is used for application activities. Provision of the learning materials is usually done via technological means such as using online VLEs (Awidi & Paynter, 2019). The findings of this study therefore have implications for the flipped classroom, particularly where mature students are a part of the cohort.

# 6 Conclusion

> If you have a system of education using computers, then anyone, any age, can learn by himself, can continue to be interested. If you enjoy learning, there's no reason why you should stop at a given age. People don't stop things they enjoy doing just because they reach a certain age. They don't stop playing tennis because they've turned forty. They don't stop with sex just because they've turned forty. They keep it up as long as they can if they enjoy it, and learning will be the same thing. The trouble with learning is that most people don't enjoy it because of the circumstances. Make it possible for them to enjoy learning, and they'll keep it up.
>
> \- Isaac Asimov in Moyers and Flowers, 1989, p. 269.

## 6.1 Summary of Findings

This study aimed to explore how attitudes to technology and TEL differed across different age groups in HE, the factors that affected these attitudes, and therefore what the implications are for designing age-inclusive learning environments. A new instrument (the Technology Attitudes Questionnaire) was designed in order to explore student attitudes for a modern cohort, and interviews were conducted with a sample of the questionnaire participants.

From my quantitative results, it was found that the students of different ages did not seem to have strikingly different attitudes towards technology and TEL, but they did use technology differently. Mature students used fewer technologies, and had been using them for a longer time. This suggests that they are more loyal to the technologies they choose to use. This implies that mature students are generally as confident and happy to use technology as younger students; furthermore, my interviews found that older students tend to be even more confident than younger students using technologies that are new to them. Overall, they do not have the fear of technology that society and educators may attribute to them, and they do not like that this perception of them exists. In fact, frequency of use may have more of an impact on technology attitude and confidence than age. Factors that affect student attitudes include their own perceived knowledge level, which links strongly with familiarity and exposure. Usefulness, purpose, and design of a technology are also major contributing factors.

## 6.2 Methodological Reflections

As my undergraduate degree was in chemistry, I come from a science background. This degree included a large amount of mathematical content, but offered little in terms of opportunities for writing, beyond a 5000-word dissertation project. I therefore considered myself throughout this study as having more of an affinity with quantitative research than qualitative research. Having said that, I feel that my statistical skills have developed significantly throughout this project; I had done very little statistical analysis previously, and therefore if I were to do the research again, I would be confident in using the correct methods from the beginning, particularly for EFA. I believe that the difference in my natural affinity between quantitative and qualitative research may have been reflected in this thesis, as I found the findings from the quantitative analysis to be easier to state clearly and succinctly. In the future, I would like to focus on developing my qualitative analysis skills, particularly my ability to distil large amounts of interview data into a small number of coherent themes.

The questionnaire and the interview were developed simultaneously, and this did mean that I was not able to build on the findings from the questionnaire in the interviews. Although I am happy with this questionnaire-interview relationship as I carried it out, I can see that there are clear opportunities for targeting my interview questions based on my quantitative findings. This is a method I would like to explore in the future.

Throughout this project, I kept a research diary, which I found to be invaluable. I used this to record my decision making processes, on everything from my search strategy to my analysis. In addition to recording what the decisions I made were, I also included discussions with myself on the reasons for each decision. This enabled me to be reflexive in my research, as well as having a document to refer back to after breaks from my research, something that was useful as my PhD was completed part-time.

## 6.3 Personal and Professional Reflections

I began this project with the simple idea that perhaps mature students had different attitudes to technology than younger students, due to differences I saw whilst teaching. Having completed the project and found that the situation is not so straightforward is fascinating to me. Since I teach mature students using learning technologies, I have been aware of the implications of my findings as they have emerged, and I have been working to develop my teaching methods to reflect these. I have begun to include more explicit, multi-level training for using technologies on my modules, and to build in time for students to learn these and gradually improve. I offer students a range of learning materials that use different technologies so that they can choose the technology they are most comfortable with. I explain to students the purpose for each technology and learning activity that we do. I believe these things have been well-received by students based on their comments. Most importantly, I no longer view mature students as being scared of technology. There are many factors at play in determining one's attitude and use of technology, and I assess each new cohort of students individually and separately.

Throughout this project I have learned how to apply and analyse both quantitative and qualitative research methods, neither of which I had done before beginning this project. Learning new methods was challenging, and I spent a lot of time understanding the methods that I have employed, including the underlying assumptions, and the trustworthiness of each method.

Furthermore, through my supervisors' feedback, as well as conference presentations and journal article submissions, I have learned how to read and accept reviews of my work, and how to respond thoughtfully and clearly to these. It is always a challenge to read criticism of your own work, and taking the time to understand the reasoning behind such criticisms and whether they are valid and can be improved upon is important. I am eager to take what I have learned forward into future research projects and publications. I value the time taken by reviews, supervisors, and examiners to enable me to become a better researcher and educator.

## 6.4 Recommendations

This section offers a distilled set of ten key recommendations for educators and institutions that arose from this project.

1. Don't view mature students as scared of technology, as this is likely to alienate them.
2. Use diagnostic assessment to determine each cohort's technological learning needs.
3. Educators should only use technologies that they themselves are comfortable and competent using.
4. The technologies chosen need a clear and explicit purpose, must be easy to use or learn, and must be more useful than analogue versions.
5. Offer a choice of technologies where possible.
6. Consider whether training to use specific technologies is needed, and if so, offer optional training sessions that introduce technology use gradually.
7. Technology-based learning resources need to follow the same rigour as non-technological learning design, using appropriate instruction, scaffolding, and pacing.
8. Interactivity is valued by students.
9. Learners want ownership over their own learning, and this is true of technology learning and use as well.
10. Universities' Learning and Teaching Strategies currently oversell technology use, and need to manage expectations on the use of technology, or at least make it clearer that this 'ideal use' is a goal.

Overall, my work offers the suggestion of a call to educators in higher education to abandon fear-related stereotypes about mature students. However, we must also be sensitive to differences for students who use technology less often in order to design age-inclusive resources and learning environments. When we use learning-enhancing technologies on our courses, we must choose the technology carefully, with good pedagogy and design criteria in the forefront of our minds. Diagnostic assessment can help us to determine the technological learning needs of particular groups of students. Learning technologies and TLEs must have clear and communicated purposes beyond traditional methods or they may cause student alienation. We must not assume that students are able to access the technology without aid, as the current COVID-19 pandemic has shown. From my questionnaire and interviews, I have concluded that educators must give students enough time to adapt and learn new technologies, particularly if the technology is not frequently used. This may involve providing explicit training opportunities throughout a course. Ideally, the option to choose from a range of technologies should be offered, which will allow students to choose those they find most familiar, easiest, and useful, as these are the factors that students rated as key in their interviews.

This study contributes to the ongoing field of technology attitudes and use, as well as the field of particular learning needs of mature students, widening participation, and age-inclusivity. This is particularly important since technology is an evolving and persistent aspect of the global higher education landscape. Knowing how and why different groups of students engage with learning technology is increasingly important in order to help them to make the most of the opportunities offered by higher education.

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# APPENDICES

## APPENDIX A: TECHNOLOGY ATTITUDES QUESTIONNAIRE (TAQ)

**Welcome**
Thank you for participating in my questionnaire.

You have the right to withdraw from this questionnaire at any time without reason. You can do this by closing the window.

If you have any questions, please contact Rachel Staddon at r.v.staddon@sheffield.ac.uk

Please read and tick the box:

☐ I confirm that I have read and understood the information sheet explaining the above research project and I have had the opportunity to ask questions about the project.

☐ I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline. Any questions can be directed to r.v.staddon@sheffield.ac.uk

☐ I understand that my responses will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research.

☐ I agree for the data collected to be used in future research.

☐ I agree to take part in the above research project.

**Section 1**
The following questions are about technologies that you have used, either for course activities or for non-course activities. Please think about technologies you have used at any time in your life, for more than a sample session. Examples have been given for each form of technology, but please feel free to think about other similar technologies you may have used.

Course activities are activities you have done for educational courses (at university, college, school, etc). These may be technologies that you have been told to use, or technologies that you personally have chosen to use for your studies.

Non-course activities are activities you have done outside formal education.

Please indicate whether you have ever made use of these forms of technology for course activities, for non-course activities, or not at all. You can choose more than one option.

If you do not know, or prefer not to answer for any reason, please choose the pass option.

| | **I have used this for course activities** | **I have used this for non-course activities** | **I have not used this/pass** |
|---|---|---|---|
| Desktop computer | | | |
| Laptop computer | | | |
| Tablet computer e.g., iPad | | | |
| Mobile phone (smartphone e.g., iPhone, Samsung Galaxy) | | | |
| Television | | | |
| Radio | | | |
| The Internet | | | |
| MP3 player e.g., iPod | | | |
| E-readers e.g., Kindle, Kobo | | | |

| | **I have used this for course activities** | **I have used this for non-course activities** | **I have not used this/pass** |
|---|---|---|---|
| Calculator | | | |
| Email | | | |
| Texting | | | |
| Voting mechanism e.g., physical clickers, voting software such as Socrative | | | |
| Instant messaging e.g., Snapchat, Whatsapp | | | |
| Video calls and conferencing e.g., Skype, Facetime, Hangouts | | | |
| Social networking e.g., Facebook, Twitter | | | |
| Office suite e.g., word processors like Microsoft Word, spreadsheets such as Excel, Powerpoint, etc. | | | |

| | **I have used this for course** | **I have used this for non-** | **I have not used this/pass** |
|---|---|---|---|

| | activities | course activities | |
|---|---|---|---|
| Videos e.g., YouTube, Netflix, Vimeo | | | |
| Online tutorials e.g., Khan Academy, iTunes U, Coursera, TED | | | |
| Wiki e.g., Wikipedia, WikiAnswers | | | |
| Online forums e.g., Reddit, The Student Room | | | |
| Virtual learning environments e.g., MOLE | | | |
| Quizzes e.g., on the computer, apps | | | |
| Games e.g., on the computer, apps, consoles | | | |

| | |
|---|---|
| Other (please state type of technology, and whether you have use this for course activities, non-course activities, or not at all) | |

**Section 2**
The following questions are about technologies that you use, either for course activities or for non-course activities. Please think about technologies that you currently use in your life. Examples have been given for each form of technology, but please feel free to think about other similar technologies you may have used.

Course activities are activities you do for educational courses (at university, college, school, etc). These may be technologies that you have been told to use, or technologies that you personally have chosen to use for your studies.

Non-course activities are activities you do outside formal education.

How often do you currently use these forms of technology? This includes any form of use, for any length of time.

| | Daily | Weekly | Monthly | Less often than monthly | Never |
|---|---|---|---|---|---|
| Desktop computer | | | | | |
| Laptop computer | | | | | |
| Tablet computer e.g., iPad | | | | | |
| Mobile phone (smartphone e.g., iPhone, Samsung Galaxy) | | | | | |
| Television | | | | | |
| Radio | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| The Internet | | | | | |
| MP3 player e.g., iPod | | | | | |
| E-readers e.g., Kindle, Kobo | | | | | |

| | **Daily** | **Weekly** | **Monthly** | **Less often than monthly** | **Never** |
|---|---|---|---|---|---|
| Calculator | | | | | |
| Email | | | | | |
| Texting | | | | | |
| Voting mechanism e.g., physical clickers, voting software such as Socrative | | | | | |
| Instant messaging e.g., Snapchat, Whatsapp | | | | | |
| Video calls and conferencing e.g., Skype, Facetime, Hangouts | | | | | |
| Social networking e.g., Facebook, Twitter | | | | | |
| Office suite e.g., word processors like Microsoft Word, spreadsheets such as Excel, Powerpoint, etc. | | | | | |

| | **Daily** | **Weekly** | **Monthly** | **Less often than monthly** | **Never** |
|---|---|---|---|---|---|
| Videos e.g., YouTube, Netflix, Vimeo | | | | | |
| Online tutorials e.g., Khan Academy, iTunes U, Coursera, TED | | | | | |
| Wiki e.g., Wikipedia, WikiAnswers | | | | | |
| Online forums e.g., Reddit, The Student Room | | | | | |
| Virtual learning environments e.g., MOLE | | | | | |
| Quizzes e.g., on the computer, apps | | | | | |
| Games e.g., on the computer, apps, consoles | | | | | |

| | |
|---|---|
| Other (please state type of technology, and how often | |

| | |
|---|---|
| you use it) | |

The following questions are about technologies that you use, either for course activities or for non-course activities. Please think about technologies that you currently use in your life.

Course activities are activities you do for educational courses (at university, college, school, etc). These may be technologies that you have been told to use, or technologies that you personally have chosen to use for your studies.

Non-course activities are activities you do outside formal education.

How long have you been using these forms of technology? This includes any form and amount of use.

| | **Less than a year** | **1-2 years** | **3-5 years** | **6-10 years** | **More than 10 years** | **Never** |
|---|---|---|---|---|---|---|
| Desktop computer | | | | | | |
| Laptop computer | | | | | | |
| Tablet computer e.g., iPad | | | | | | |
| Mobile phone (smartphone e.g., iPhone, Samsung Galaxy) | | | | | | |
| Television | | | | | | |
| Radio | | | | | | |
| The Internet | | | | | | |
| MP3 player e.g., iPod | | | | | | |
| E-readers e.g., Kindle, Kobo | | | | | | |

| | **Less than a year** | **1-2 years** | **3-5 years** | **6-10 years** | **More than 10 years** | **Never** |
|---|---|---|---|---|---|---|
| Calculator | | | | | | |
| Email | | | | | | |
| Texting | | | | | | |
| Voting mechanism e.g., physical clickers, voting software such as Socrative | | | | | | |
| Instant messaging e.g., Snapchat, Whatsapp | | | | | | |
| Video calls and conferencing e.g., Skype, Facetime, Hangouts | | | | | | |
| Social networking e.g., | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Facebook, Twitter | | | | | | |
| Office suite e.g., word processors like Microsoft Word, spreadsheets such as Excel, Powerpoint, etc. | | | | | | |

| | **Less than a year** | **1-2 years** | **3-5 years** | **6-10 years** | **More than 10 years** | **Never** |
|---|---|---|---|---|---|---|
| Videos e.g., YouTube, Netflix, Vimeo | | | | | | |
| Online tutorials e.g., Khan Academy, iTunes U, Coursera, TED | | | | | | |
| Wiki e.g., Wikipedia, WikiAnswers | | | | | | |
| Online forums e.g., Reddit, The Student Room | | | | | | |
| Virtual learning environments e.g., MOLE | | | | | | |
| Quizzes e.g., on the computer, apps | | | | | | |
| Games e.g., on the computer, apps, consoles | | | | | | |

| | |
|---|---|
| Other (please state type of technology, and how long you have used it) | |

**Section 3**
This section is about your attitudes to and experiences with technology that you have used for educational purposes.

Please indicate how you feel about the following statements, from entirely agree to entirely disagree.

If you do not know or prefer not to answer for any reason, please choose the pass option.

| | Entirely disagree | Mostly disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Mostly agree | Entirely agree | Pass |
|---|---|---|---|---|---|---|---|---|
| Technology can help me organise my studies | | | | | | | | |
| Technology allows me to learn wherever I need to | | | | | | | | |
| Technology allows students to learn at their own pace | | | | | | | | |
| I learn more rapidly when I use technology | | | | | | | | |
| Most things that I can do with technology can be done through other means | | | | | | | | |

| | Entirely disagree | Mostly disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Mostly agree | Entirely agree | Pass |
|---|---|---|---|---|---|---|---|---|
| It takes longer to learn to use technology than to do the job manually | | | | | | | | |
| Technology makes my study activities more personal and my own | | | | | | | | |
| I like using technology | | | | | | | | |
| The use of technology increases my motivation to study | | | | | | | | |
| The use of technology makes a course more interesting | | | | | | | | |

| | Entirely disagree | Mostly disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Mostly agree | Entirely agree | Pass |
|---|---|---|---|---|---|---|---|---|
| Technology stops me from being bored | | | | | | | | |
| I am tired of using technology | | | | | | | | |
| I am good at using technology | | | | | | | | |
| I find it easy to get technology to do what I want it to do | | | | | | | | |
| Technology makes me uncomfortable | | | | | | | | |
| I find technology confusing | | | | | | | | |

| | Entirely disagree | Mostly disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Mostly agree | Entirely agree | Pass |
|---|---|---|---|---|---|---|---|---|
| I generally feel confident working with technology | | | | | | | | |
| I am easily able to learn new technology skills | | | | | | | | |
| I feel comfortable using technology | | | | | | | | |
| I am most confident with the forms of technology I am most familiar with | | | | | | | | |
| When I use computers, I feel in control | | | | | | | | |

| | **Entirely disagree** | **Mostly disagree** | **Somewhat disagree** | **Neither agree nor disagree** | **Somewhat agree** | **Mostly agree** | **Entirely agree** | **Pass** |
|---|---|---|---|---|---|---|---|---|
| I am comfortable using technology I have chosen in my home | | | | | | | | |
| Technology makes me nervous | | | | | | | | |
| Technology makes me feel stupid | | | | | | | | |
| Using technology in my home makes me anxious, even if I have chosen it | | | | | | | | |
| I would like to know more about technology generally | | | | | | | | |

| | **Entirely disagree** | **Mostly disagree** | **Somewhat disagree** | **Neither agree nor disagree** | **Somewhat agree** | **Mostly agree** | **Entirely agree** | **Pass** |
|---|---|---|---|---|---|---|---|---|
| Technology is fascinating | | | | | | | | |
| I only use technology when told to | | | | | | | | |
| I don't want to know more about technology | | | | | | | | |
| I feel I need more training to use technology properly | | | | | | | | |
| I need an experienced person nearby when I use technology | | | | | | | | |

If you would like to add anything about your experiences of using technology for educational or non-educational purposes, please comment in the box below.

[Free-text box]

**Section 4**
The following questions are about you, to help me analyse the data. If you do not know or prefer not to answer for any reason, please choose the pass option.

Please tick which age bracket you fall into:
☐ 0-17
☐ 18-21
☐ 22-25
☐ 26-30
☐ 31-40
☐ 41-50
☐ 51-60
☐ 61-70
☐ 71+
☐ Pass

What discipline does your course fall into? Please tick one.
☐ Arts and humanities
☐ Engineering
☐ Social sciences
☐ The sciences (including maths)
☐ Pass
☐ Other (please specify)

Are you studying full time or part time? Please tick one.
☐ Full time
☐ Part time
☐ Pass

**Request for further participation and prize draw**

Would you like to be entered for the prize draw for one of two £10 Amazon vouchers? You do not have to participate further in the study in order to be entered for the draw.
□ Yes
□ No

It would be very valuable to me if you could also participate in a follow-up interview that would help me to gain more detail about your responses. The interview would take around 30 minutes, and would take place this semester, at a location within the University of Sheffield. Interview times will be flexible to suit you. There will be a further prize draw of a £10 Amazon voucher for taking part.

Would you be happy to be contacted for further participation in the study? You are not committing yourself to participating, and you may withdraw at any time without reason.
□ Yes

□ No

If you have chosen “Yes” to either of the questions above (to be entered into the prize draw or to participate further), please give your email address below.
[Free-text box]

**Thank you**
Thank you so much for participating in this study, your views are invaluable. If you have any questions about the questionnaire, please contact me at r.v.staddon@sheffield.ac.uk

Click the Done button below to exit the survey.

# APPENDIX B: ETHICS APPLICATION

The University Of Sheffield.

# Application 011645

## Section A: Applicant details

Created:
Sun 16 October 2016 at 17:53

First name:
Rachel

Last name:
Staddon

Email:
rvstaddon1@sheffield.ac.uk

Programme name:
PhD

Module name:
PhD
Last updated:
07/11/2016

Department:
School of Education

Date application started:
Sun 16 October 2016 at 17:53

Applying as:
Postgraduate research

Research project title:
Mature students and their experiences of and attitudes to technology-enhanced learning: developing design criteria for a web-based resource

## Section B: Basic information

### 1. Supervisor(s)

| Name | Email |
|---|---|
| Jon Scaife | j.a.scaife@sheffield.ac.uk |

## 2: Proposed project duration

Proposed start date:
Tue 1 November 2016

Proposed end date:
Thu 1 December 2016

## 3: URMS number (where applicable)

URMS number
*- not entered -*

## 4: Suitability

Takes place outside UK?
No

Involves NHS?
No

Healthcare research?
No

ESRC funded?
No

Involves adults who lack the capacity to consent?
No

Led by another UK institution?
No

Involves human tissue?
No

Clinical trial?
No

Social care research?
No

## 5: Vulnerabilities

Involves potentially vulnerable participants?
No
Involves potentially highly sensitive topics?
No

## Section C: Summary of research

### 1. Aims & Objectives

The aim is to explore the attitudes of mature students to technology-enhanced learning (TEL) compared to younger higher education students. It also aims to begin to find out which factors affect their attitudes and confidence with TEL, and whether attitudes and factors vary between different ages of mature student.

This is one part of a larger study that explores the attitudes and experiences of mature students with TEL, working towards developing a set of criteria for a web-based learning resource designed for mature students.

### 2. Methodology

This part of the study will be done via a questionnaire, and a number of follow-up semi-structured interviews with participants of a range of ages/responses. The instruments will be piloted first.

An invitation to participate in the research will be circulated via email to potential participants (please see attached invitation), along with the information sheet (attached). The questionnaire (attached) will be linked within this participation invitation, administered through SurveyMonkey.

Participants will complete the questionnaire, and 4-6 participants who have provided their e-mail address will be contacted and invited to participate in follow-up interviews (schedule attached). Interviews will be tape-recorded, then transcribed and coded.

Cronbach's Alpha will be found for the Likert items to measure reliability. Other analyses may be chi-square tests and confirmatory factor analysis.

### 3. Personal Safety

Raises personal safety issues? No

Pesonal safety management

*- not entered -*

## Section D: About the participants

### 1. Potential Participants

The participants will be students in the University of Sheffield. A mix of participants of different ages, including mature students, is needed.

### 2. Recruiting Potential Participants

An invitation to participate in the study, with information sheet and link to the online survey, will be emailed out to the student volunteers mailing list.

### 2.1 Advertising methods

Will the study be advertised using the volunteer lists for staff or students maintained by CiCS? Yes

Since I would like I to get some mature students, I considered approaching students I teach (mature students in DLL) for assistance. However, this was deemed unsuitable due to the possibility of them feeling under pressure to participate as I am in authority over them. It would also not reach all of the target groups, who also include non-mature undergraduates.

### 3. Consent

Will informed consent be obtained from the participants? (i.e. the proposed process) Yes

The information sheet will be sent round with the invitation email. An online consent form will be the first page of the questionnaire. For interview participants, a paper-based consent form (attached) will be signed by the participant and researcher at the time of the interview.

### 4. Payment

Will financial/in kind payments be offered to participants? Yes

I am planning to provide entry into a prize draw for Amazon vouchers for the main study (not the pilot). There will be a draw for those completing the questionnaire of a Â£10 Amazon voucher, and a further Â£10 Amazon voucher draw for interviewees. Â£10 was chosen as it seems reasonable compensation (neither too large not too small) for the expected amount of time given by the participants.

### 5. Potential Harm to Participants

What is the potential for physical and/or psychological harm/distress to the participants?

No physical harm is expected. Other harm or distress is not anticipated, other than a small time inconvenience for filling out the questionnaire and attending the interview.

How will this be managed to ensure appropriate protection and well-being of the participants?

A link is given in the information sheet to the university counselling service, should participants experience any distress. Compensation for time inconvenience participating in the research is the prize draw, as detailed above.

## Section E: About the data

### 1. Data Confidentiality Measures

Any information collected about the participants during the course of the research will be kept strictly confidential. Any results will be anonymised, and participants will not be able to be identified in any reports or publications. Audio recordings of interviews will be used only for analysis, and transcriptions may be used for illustration in conference presentations and lectures. No other use will be made without the written permission of the participant, and no one outside the project will be allowed access to the original recordings. The recordings will kept stored in a secure location, and destroyed at the end of the project. Informed consent will be obtained specifically to make audio recordings of the interview.

### 2. Data Storage

I will store the data (original audio recordings and non-anonymous transcriptions) in a Google Drive folder accessible only by myself, on my password-protected computer. Anonymised transcriptions will be created immediately after doing the non-anonymous transcripts, and these will also be stored in that location on my computer. It is the anonymised versions that will be used for the analysis of the data, undertaken by myself and supervised by my PhD supervisors.

Only the research team will have access to the data - this includes myself, my two supervisors (Jon Scaife and Andy McLean), and any examiners.

The non-anonymous data will not be used in future projects, and the audio recordings will be destroyed at the end of this project. The anonymised data may be used for publications and conferences.

## Section F: Supporting documentation

### Information & Consent

Participant information sheets relevant to project?
Yes

**Participant Information Sheets**

- Information_Sheet.docx
  (Document 029553)

Consent forms relevant to project?
Yes

**Consent Forms**

- Consent_form.docx
  (Document 029554)

### Additional Documentation

- Invitation_e-mail.docx (Document 029555)
  Invitation email
- Questionnaire.docx (Document 029556)
  Questionnaire (MS Word copy)
- Interview_Schedule.docx (Document 029557)
  Interview schedule

### External Documentation

*- not entered -*

Offical notes

*- not entered -*

Section G: Declaration

Signed by:
Rachel Victoria Staddon
Date signed:
Mon 17 October 2016 at 22:06

## APPENDIX C: INFORMATION SHEET

# Information Sheet: Researching Uses of Technology in Teaching and Learning

**Research project title**
Students' experiences of and attitudes to technology-enhanced learning

**Invitation**
You are being invited to take part in a research project. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take the time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take your time to decide whether or not you wish to take part. Thank you for reading.

**Purpose of the project**
This project aims to explore how students view learning technologies, and their experiences with them. It aims to help tutors and lecturers make good use of technology in academic activity.

**Why have I been chosen?**
You have been chosen because, as a university student, you will have unique experience of technology-enhanced learning from a student point of view. It would be very valuable to me if you were able to share your experiences in the following questionnaire.

**Do I have to take part?**
It is completely up to you whether or not to take part. If you do decide to take part, you can withdraw at any time without it affecting any benefits that you are entitled to in any way. You do not have to give a reason.

**What will happen to me if I take part?**
You will be asked to complete a one-time web-based questionnaire that I estimate will take you approximately 20 minutes. You may be invited to a follow-up interview to find out more about your views of technology.

**What do I have to do?**
Please answer the questions in the questionnaire. There are no other commitments or restrictions associated with participating.

**Will I be recorded, and how will the recorded media be used?**
If you participate in the interview part of this study, you will be asked to consent to having the interview voice-recorded. You do not have to agree to this to participate in the interview. The audio recording will be used only for analysis, and transcriptions may be used for illustration in conference presentations and lectures. No other use will be made without your written permission, and no one outside the project will be allowed access to the original recordings. The

recordings will kept stored in a secure location, and destroyed at the end of the project. Your identity will remain anonymous throughout.

**What are the possible disadvantages and risks of taking part?**
Participating in the research is not anticipated to cause you any disadvantage, discomfort or distress. In the unlikely event you experience any distress from the questionnaire or subsequent interview, there are a range of services available to help, including your departmental student welfare officer, and the University Counselling Service (http://www.sheffield.ac.uk/ssid/counselling).

**What are the possible benefits of taking part?**
If you wish to be, you will be entered into a prize draw for a £10 Amazon voucher. Whilst there are no further immediate benefits for those people participating in the project, it is hoped that this work will help tutors and lecturers to make good use of learning technologies in their courses.

**What happens if the research study stops earlier than expected?**
If this occurs and you are affected in any way, I will contact you to explain why the study has stopped.

**What if something goes wrong?**
If you have any complaints or concerns about the project, please feel free to contact me or my supervisors (contact details given at the end of the information sheet). If you feel your complaint or concern has not been handled to your satisfaction, please contact Professor Liz Wood, the Head of the School of Education.

**Will my taking part in this project be kept confidential?**
Yes. Any information collected about you during the course of the research will be kept strictly confidential. You will not be able to be identified in any reports or publications. The data collected will be stored in a password-protected location.

**What type of information will be sought from me and why is the collection of this information relevant for achieving the research project's objectives?**
The questionnaire will ask you about the types of technology you use, and how you feel about technology. The project is about student's views and experiences, so you will contributing invaluably.

**What will happen to the results of the research project?**
The data is currently being collected for my PhD studies. The results will therefore be used in my thesis. I hope that any results will also be published in an academic journal. You will not be able to be identified in any publication. If you wish to receive a copy of any publications resulting from the research, please feel free to email me and ask to be put on my circulation list.

**Who is organising and funding the research?**
The University of Sheffield.

**Who has ethically reviewed the project?**

This project has been ethically approved via the School of Education's ethics review procedure. The University's Research Ethics Committee monitors the application and delivery of the University Ethics Review Procedure across the University.

**Contact for further information**
Rachel Staddon, PhD student in the School of Education, University of Sheffield.
Email: r.v.staddon@sheffield.ac.uk

Dr Jon Scaife, School of Education, University of Sheffield.
Email: j.a.scaife@sheffield.ac.uk

Dr Andy Mclean, School of Education, University of Sheffield.
Email: a.mclean@sheffield.ac.uk

Thank you for taking part in this research.

## Appendix D: Consent Form

# Participant Consent Form

**Title of Research Project**
Students' experiences of and attitudes to technology-enhanced learning

**Name of Researcher**
Rachel Staddon

Participant Identification Number

____________________

Please read and initial in the box:

| | |
|---|---|
| I confirm that I have read and understood the information sheet explaining the above research project and I have had the opportunity to ask questions about the project. | |
| I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline. Any questions can be directed to r.v.staddon@sheffield.ac.uk | |
| I understand that my responses will be kept strictly confidential. I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research. | |
| I agree that the interview may be audio recorded, and that an anonymised transcription may be used for the project. | |
| I agree for the data collected to be used in future research. | |
| I agree to take part in the above research project. | |

Name of participant    Date    Signature

Name of researcher    Date    Signature

## APPENDIX E: INTERVIEW PROTOCOL

# Interview Protocol

### Opening

1. [Establish rapport] Welcome, I'm Rachel. How are you?

2. [Purpose] I would like to ask you some questions about your experiences with technology-enhanced learning, following on from the questionnaire you did online. I'm hoping this will help lecturers and tutors use technology better.

3. [Timeline] The interview should take about half an hour, is that okay with you?

4. [Sign 2 consent forms and obtain permission to audio record – begin recording]

5. [Structure] I'm hoping to talk to you about what you understand by technology-enhanced learning, what you enjoy, your confidence

### Starting the conversation - concepts

1. What do you understand by the term technology-enhanced learning?

### Enjoyment

1. Do you generally enjoy using technology for learning?

2. Do you enjoy using technology generally?

3. Which forms of technology are the most enjoyable to use for learning?
    a. Why?

4. Which forms of technology are the least enjoyable to use for learning?
    a. Why?

5. Which forms of technology are the most enjoyable to use for your personal use/non-course activities?
    a. Why?

6. Which forms of technology are the least enjoyable to use for your personal use/non-course activities?
    a. Why?

**Confidence**

1. How confident would you say you were with technology?
    a. On a scale of 1 to 10?
    b. Why?
    c. What affects your confidence with technology?
        i. If something goes wrong?

2. Which forms of technology are you the most confident using? (from list from Section 1 of the questionnaire)
    a. Why?

3. Which forms of technology are you the least confident using? (from list from Section 1 of the questionnaire)
    a. Why?

4. How confident would you say you were when *learning* about technology?
    a. On a scale of 1 to 10?
    b. Why?
    c. What affects your confidence when learning about technology?

5. Do you feel you need support for the technology you are using?
    a. Do you seek support if you need it?
    b. Who from?

6. Are you ever anxious about technology?
    a. Why?
    b. When are you most anxious?
        i. Before using it?
        ii. During using it?
        iii. After using it?

**Knowledge**

1. Do you have any ICT, computing, or other technology qualifications?
    a. Which qualification? GCSE/O-level/etc
    b. When did you get the qualification, roughly?

2. What do you understand by 'technology knowledge'?
    a. Do you feel knowledgeable about technology?

3. How knowledgeable do you feel you are about technology compared to:
    a. Other people your age?
    b. People younger than you?
    c. People older than you?
    d. Your friends?
    e. Your family?

4. Which technologies did you use before coming to university?
    a. Which were introduced to you by the university?

**Closing**

1. [Extra info]
    a. Is there anything else you think it would be helpful for me to know?
    b. Anything else you would like to add?

2. [Maintain rapport] Thank you very much for the time you took for this interview. As agreed, you will be entered into a draw for the £10 Amazon voucher. [Give them one consent form to keep]

3. Would it be okay if I contacted you if I have any more questions?

4. Thank you again.

## Appendix F: Invitation to Participate - Questionnaire

**Survey on your use of technology: chance to win £10 Amazon voucher**

Dear all,

I would like to invite you to participate in a web-based questionnaire about your attitudes and experiences of different technologies that you have used. The research aims to help tutors and lecturers make good use of technology in academic activity and, by participating, you may help to influence teaching practice. The questionnaire should take around 20 minutes to complete.

Participants who complete the questionnaire will have the opportunity to be entered into a prize draw for one of two £10 Amazon vouchers. Volunteers for interviewing will also be entered into a draw for a further £10 Amazon voucher.

If you are happy to take part, please click the link below to open the questionnaire.

https://www.surveymonkey.co.uk/r/JNXTCC6

Ethical approval for this study has been granted by the University. You have the right to withdraw from the study at any time, without reason.

Your data will be recorded and stored anonymously. It will be used within my PhD thesis in an anonymised form, and may be used in publications. You will not be identifiable in any way.

This study is being conducted as part of my PhD in Education, under the supervision of Dr Jon Scaife (j.a.scaife@sheffield.ac.uk). If you would like to learn more about the study, please see the information sheet at https://drive.google.com/open?id=0B8m4KkaC3EgcSEdPNmJnVDNISmc. If you have any questions, please feel free to contact me at r.v.staddon@sheffield.ac.uk.

Thank you for your time.

Rachel Staddon
PhD student in the School of Education
University of Sheffield

## Appendix G: Invitation to Participate - Interview

**Interview invitation: survey on your use of technology**

Dear [name],

Thank you for participating in my questionnaire about your attitudes and experiences of different technologies!

You gave your email address to be contacted for a follow-up interview. The interview will take approximately 30 minutes (although this is flexible if there's more you'd like to share), and will take place at a location within the University of Sheffield. Refreshments (tea, coffee, biscuits, etc.) will be provided. I'll email to confirm the location once we've agreed a time, if you are happy to participate.

As I mentioned in the questionnaire, there is no obligation to agree to be interviewed, but it would be very helpful to me to talk more about your experiences of technology, and also to get your opinions on my questionnaire. If you agree to participate, you will be offered the opportunity to enter the prize draw for a £10 Amazon voucher. This is in addition to the draw for completing the questionnaire, which you will still be entered into if you chose to be.

If you're happy to participate in the interview, click on the link below to open a Google Calendar of available interview slots. The available slots are shown as grey boxes labelled "technology attitudes interview". Please click on a slot and press "save" to claim it.

https://calendar.google.com/calendar/selfsched?sstoken=UU9Rc0F2dFNrZGFOfGRlZmF1bHR8ODMwMzc5ZTBmMDI5ZWRhOTQ4ZTUwZGEzN2E4NDk0Zjk

If you can't make any of the offered slots but would still like to participate, or the link doesn't work for any reason, please drop me an email and we can arrange a different time.

Thank you once again!

Rachel Staddon
PhD student in the School of Education
University of Sheffield

Ethical approval for this study has been granted by the University. You have the right to withdraw from the study at any time, without reason.

Your data will be recorded and stored anonymously. It will be used within my PhD thesis in an anonymised form, and may be used in publications. You will not be identifiable in any way.

This study is being conducted as part of my PhD in Education, under the supervision of Dr Jon Scaife (j.a.scaife@sheffield.ac.uk). If you would like to learn more about the study, please see the information sheet at https://drive.google.com/open?id=0B8m4KkaC3EgcSEdPNmJnVDNISmc. If you have any questions, please feel free to contact me at r.v.staddon@sheffield.ac.uk.

## Appendix H: Interview Invitation Reminder

### Interview Invitation Reminder

Dear [name],

Just a reminder that should you still wish to participate in my study on students' attitudes and experiences of different technologies, I still have interview slots available, including for after the exam period.

Each interview will take approximately 30 mins, and you will be offered the opportunity to enter the prize draw for a £10 Amazon voucher. The link below opens my Google Calendar of available interview slots. The available slots are shown as grey boxes labelled "technology attitudes interview". Please click on a slot and press "save" to claim it.

https://calendar.google.com/calendar/selfsched?sstoken=UU9Rc0F2dFNrZGFOfGRlZmF1bHR8ODMwMzc5ZTBmMDI5ZWRhOTQ4ZTUwZGEzN2E4NDk0Zjk

Thank you once again!

Rachel Staddon
PhD student in the School of Education
University of Sheffield

Ethical approval for this study has been granted by the University. You have the right to withdraw from the study at any time, without reason.

Your data will be recorded and stored anonymously. It will be used within my PhD thesis in an anonymised form, and may be used in publications. You will not be identifiable in any way.

This study is being conducted as part of my PhD in Education, under the supervision of Dr Jon Scaife (j.a.scaife@sheffield.ac.uk). If you would like to learn more about the study, please see the information sheet at https://drive.google.com/open?id=0B8m4KkaC3EgcSEdPNmJnVDNISmc. If you have any questions, please feel free to contact me at r.v.staddon@sheffield.ac.uk.

## Appendix I: Interview Confirmation

### Interview confirmation: survey on your use of technology

(reply to the email I sent regarding signing up)

Dear [name],

Thank you for agreeing to participate in a follow-up interview about your attitudes and experiences of different technologies. This is to confirm that you've signed up for an interview slot at [TIME] on [DATE].

The interview will be held in the Department for Lifelong Learning in Edgar Allen House (241 Glossop Road). The link below has a map if needed.

https://www.google.com/maps/place/53%C2%B022'48.4%22N+1%C2%B028'58.3%22W/@53.380128,-1.482904,16z/data=!4m5!3m4!1s0x0:0x0!8m2!3d53.3801111!4d-1.4828611?hl=en-GB

When you enter the building, there will be some stairs straight in front of you. Alternatively, there is a lift. Go up one floor, then go to the end of the short corridor and enter the door there to reception. Please ask for Rachel Staddon when you arrive.

If you need to change your slot, you can either let me know, or go into the calendar link in my previous email to book another slot.

I look forward to seeing you on the [DATE]!

Rachel

## APPENDIX J: EXAMPLE VERBATIM TRANSCRIPT AND SIMPLIFIED TRANSCRIPT

### Bill – Attitudes to TEL – Verbatim Interview Transcript

*R = Rachel*
*P = participant*

R: ok, so this is just um to ask you some questions about um your experiences with technology and technology-enhanced learning. So it's following o- on from the online questionnaire that you did. Um. And I'm hoping that this will enable us um to make lessons better, to help lecturers design technology better.

P: that's good, ok.

R: so the interview should take about half an hour, um although there's more time if you want it, um, is that ok with you?

P: yeah that's fine.

R: fantastic. Ok, so overall I'm hoping to talk to you about what you understand by technology-enhanced learning, what you enjoy, um, how confident you are with it, et cetera. So, first of all, um, when I say "technology-enhanced learning" or "e-learning" to you, what do you understand by that?

P: um, well personally probably the enhancement bit – I have dyslexia, so

R: ok

P: I haven't done it yet, but I know there's DDS, I think it is.

R: /Mm hm

P: /Which is, like, um, even that, for example, like there are different technologies out there, different programs and whatnot that can enhance one's learning even if they have a disability.

R: /Mm hm

P: /but then also like I- I've been to different workshops and stuff where they use like clicker voting thing, and kind of like different ah- interactions with uh like the powerpoint and stuff like that which I think is quite helpful so.

R: cool. Um do you generally enjoy using technology for learning?

P: Um [pause] ye:s, but I think mostly just because that's the onl-, like, the only, the main thing I'm used to.

R: Mm hm

**Bill – Attitudes to TEL – Simplified Interview Transcript**

*R = Rachel*
*P = participant*

R: ok, so this is just to ask you some questions about your experiences with technology and technology-enhanced learning. So it's following on from the online questionnaire that you did. And I'm hoping that this will enable us to make lessons better, to help lecturers design technology better.

P: that's good, ok.

R: so the interview should take about half an hour, although there's more time if you want it, is that ok with you?

P: yeah that's fine.

R: fantastic. Ok, so overall I'm hoping to talk to you about what you understand by technology-enhanced learning, what you enjoy, how confident you are with it, et cetera. So, first of all, when I say "technology-enhanced learning" or "e-learning" to you, what do you understand by that?

P: well personally probably the enhancement bit. I have dyslexia.

R: ok

P: I haven't done it yet, but I know there's DDS, I think it is. For example, there are different technologies out there, different programs and whatnot that can enhance one's learning even if they have a disability. But then also I've been to different workshops and stuff where they use like clicker voting thing, and kind of different interactions with the Powerpoint and stuff like that which I think is quite helpful .

R: cool. Do you generally enjoy using technology for learning?

P: [pause] Yes but I think mostly just because that's the main thing I'm used to.

## APPENDIX K: ADDITIONAL RESULTS TABLES

**Table K.1**

*Percentages of use of different technologies for course activities only, non-course activities only, and both, by age range. Percentages include participants who said they used neither (not shown in table); n=161*

| Technology | Age | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 18-21 (n=71) | | | 22-25 (n=41) | | | 26-30 (n=18) | | | 31-40 (n=17) | | | 41-50 (n=8) | | | 51-60 (n=1) | | | 61-70 (n=5) | | |
| | Course | Non-course | Both | Course | Non-course | Both | Course | Non-course | Both | Course | Non-course | Both | Course | Non-course | Both | Course | Non-course | Both | Course | Non-course | Both |
| Desktop computer | 14.1 | 1.4 | 74.6 | 24.4 | 0.0 | 70.7 | 22.2 | 0.0 | 72.2 | 17.6 | 5.9 | 76.5 | 12.5 | 0.0 | 87.5 | 0.0 | 0.0 | 100 | 20.0 | 0.0 | 80.0 |
| Laptop computer | 2.8 | 1.4 | 95.8 | 12.2 | 9.8 | 78.0 | 5.6 | 0.0 | 94.4 | 11.8 | 0.0 | 82.4 | 12.5 | 0.0 | 87.5 | 0.0 | 0.0 | 100 | 0.0 | 20.0 | 80.0 |
| Tablet computer | 0.0 | 33.8 | 39.4 | 7.3 | 19.5 | 46.3 | 0.0 | 22.2 | 38.9 | 5.9 | 23.5 | 47.1 | 0.0 | 37.5 | 37.5 | 0.0 | 0.0 | 100 | 0.0 | 0.0 | 60.0 |
| Mobile telephone | 0.0 | 16.9 | 83.1 | 7.3 | 12.2 | 78.0 | 0.9 | 38.9 | 61.1 | 11.8 | 23.5 | 58.8 | 12.5 | 25.0 | 50.0 | 0.0 | 0.0 | 100 | 0.0 | 20.0 | 60.0 |
| Television | 0.0 | 69.0 | 19.7 | 0.0 | 65.9 | 9.8 | 0.0 | 72.2 | 5.6 | 0.0 | 76.5 | 11.8 | 12.5 | 37.5 | 37.5 | 0.0 | 100 | 0.0 | 0.0 | 60.0 | 20.0 |
| Radio | 0.0 | 64.8 | 9.9 | 0.0 | 58.5 | 7.3 | 0.0 | 72.2 | 5.6 | 0.0 | 64.7 | 5.9 | 0.0 | 62.5 | 12.5 | 0.0 | 100 | 0.0 | 0.0 | 60.0 | 40.0 |
| The Internet | 2.8 | 1.4 | 68 | 12.2 | 2.4 | 82.9 | 5.6 | 0.0 | 94.4 | 11.8 | 5.9 | 82.4 | 12.5 | 0.0 | 87.5 | 0.0 | 0.0 | 100 | 0.0 | 0.0 | 100 |
| MP3 player | 0.0 | 76.1 | 4.2 | 2.4 | 53.7 | 14.6 | 0.0 | 72.2 | 11.1 | 0.0 | 52.9 | 11.8 | 12.5 | 37.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 20.0 | 0.0 |
| E-reader | 1.4 | 31.0 | 4.2 | 7.3 | 24.4 | 19.5 | 0.0 | 38.9 | 5.6 | 5.9 | 29.4 | 29.4 | 12.5 | 37.5 | 12.5 | 0.0 | 0.0 | 100 | 0.0 | 0.0 | 20.0 |
| Calculator | 22.5 | 7.0 | 63.4 | 29.3 | 14.6 | 48.8 | 16.7 | 11.1 | 72.2 | 11.8 | 47.1 | 41.2 | 12.5 | 12.5 | 62.5 | 0.0 | 0.0 | 100 | 20.0 | 40.0 | 40.0 |
| Email | 2.8 | 0.0 | 97.2 | 12.2 | 0.0 | 87.8 | 11.1 | 0.0 | 88.9 | 17.6 | 11.8 | 70.6 | 12.5 | 0.0 | 87.5 | 0.0 | 0.0 | 100 | 0.0 | 0.0 | 100 |
| Texting | 2.8 | 64.8 | 32.4 | 7.3 | 65.9 | 24.4 | 0.0 | 55.6 | 38.9 | 5.9 | 52.9 | 41.2 | 0.0 | 50.0 | 50.0 | 0.0 | 0.0 | 100 | 0.0 | 60.0 | 20.0 |
| Voting mechanism | 45.1 | 7.0 | 18.3 | 48.8 | 7.3 | 9.8 | 33.3 | 0.0 | 0.0 | 17.6 | 23.5 | 11.8 | 62.5 | 25.0 | 12.5 | 0.0 | 0.0 | 0.0 | 20.0 | 20.0 | 20.0 |
| Instant messaging | 0.0 | 57.7 | 40.8 | 7.3 | 56.1 | 31.7 | 0.0 | 50.0 | 33.3 | 0.0 | 58.8 | 29.4 | 12.5 | 25.0 | 37.5 | 0.0 | 100 | 0.0 | 0.0 | 0.0 | 0.0 |
| Video calls and conferencing | 0.0 | 60.6 | 29.6 | 4.9 | 63.4 | 24.4 | 5.6 | 66.7 | 16.7 | 5.9 | 47.1 | 41.2 | 12.5 | 50.0 | 0.0 | 0.0 | 0.0 | 100 | 0.0 | 0.0 | 40.0 |
| Social networking | 0.0 | 43.7 | 56.3 | 4.9 | 31.7 | 56.1 | 0.0 | 55.6 | 44.4 | 0.0 | 29.4 | 58.8 | 12.5 | 12.5 | 75.0 | 0.0 | 0.0 | 100 | 20.0 | 0.0 | 20.0 |
| Office suite | 8.5 | 0.0 | 91.5 | 14.6 | 2.4 | 80.5 | 11.1 | 0.0 | 88.9 | 5.9 | 0.0 | 94.1 | 25.0 | 0.0 | 75.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100 |
| Videos | 1.4 | 22.5 | 76.1 | 7.3 | 26.8 | 65.9 | 0.0 | 22.2 | 77.8 | 5.9 | 29.4 | 64.7 | 12.5 | 25.0 | 62.5 | 0.0 | 100 | 0.0 | 0.0 | 40.0 | 20.0 |
| Online tutorials | 18.3 | 16.9 | 38.0 | 17.1 | 22.0 | 41.5 | 11.1 | 33.3 | 33.3 | 0.0 | 29.4 | 47.1 | 25.0 | 12.5 | 37.5 | 0.0 | 100 | 0.0 | 60.0 | 20.0 | 0.0 |
| Wiki | 4.2 | 12.7 | 83.1 | 12.2 | 7.3 | 73.2 | 5.6 | 16.7 | 77.8 | 5.9 | 47.1 | 41.2 | 12.5 | 12.5 | 75.0 | 0.0 | 0.0 | 0.0 | 20.0 | 40.0 | 40.0 |
| Online forums | 8.5 | 46.5 | 23.9 | 12.2 | 41.5 | 24.4 | 11.1 | 33.3 | 11.1 | 0.0 | 47.1 | 5.9 | 37.5 | 12.5 | 12.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Virtual learning environments | 83.1 | 1.4 | 15.5 | 78.0 | 2.4 | 17.1 | 100 | 0.0 | 0.0 | 58.8 | 0.0 | 35.3 | 50.0 | 0.0 | 50.0 | 100 | 0.0 | 0.0 | 60.0 | 0.0 | 40.0 |
| Quizzes | 14.1 | 29.6 | 45.1 | 14.6 | 31.7 | 36.6 | 5.6 | 16.7 | 38.9 | 5.9 | 52.9 | 29.4 | 25.0 | 37.5 | 12.5 | 0.0 | 100 | 0.0 | 0.0 | 20.0 | 40.0 |
| Games | 0.0 | 76.1 | 15.5 | 2.4 | 58.5 | 14.6 | 0.0 | 72.2 | 5.6 | 0.0 | 88.2 | 0.0 | 0.0 | 37.5 | 25.0 | 0.0 | 100 | 0.0 | 0.0 | 60.0 | 0.0 |

**Figure K.1**

*Preliminary main study: EFA scree plot from rawpar.sps for 31-item attitude section*

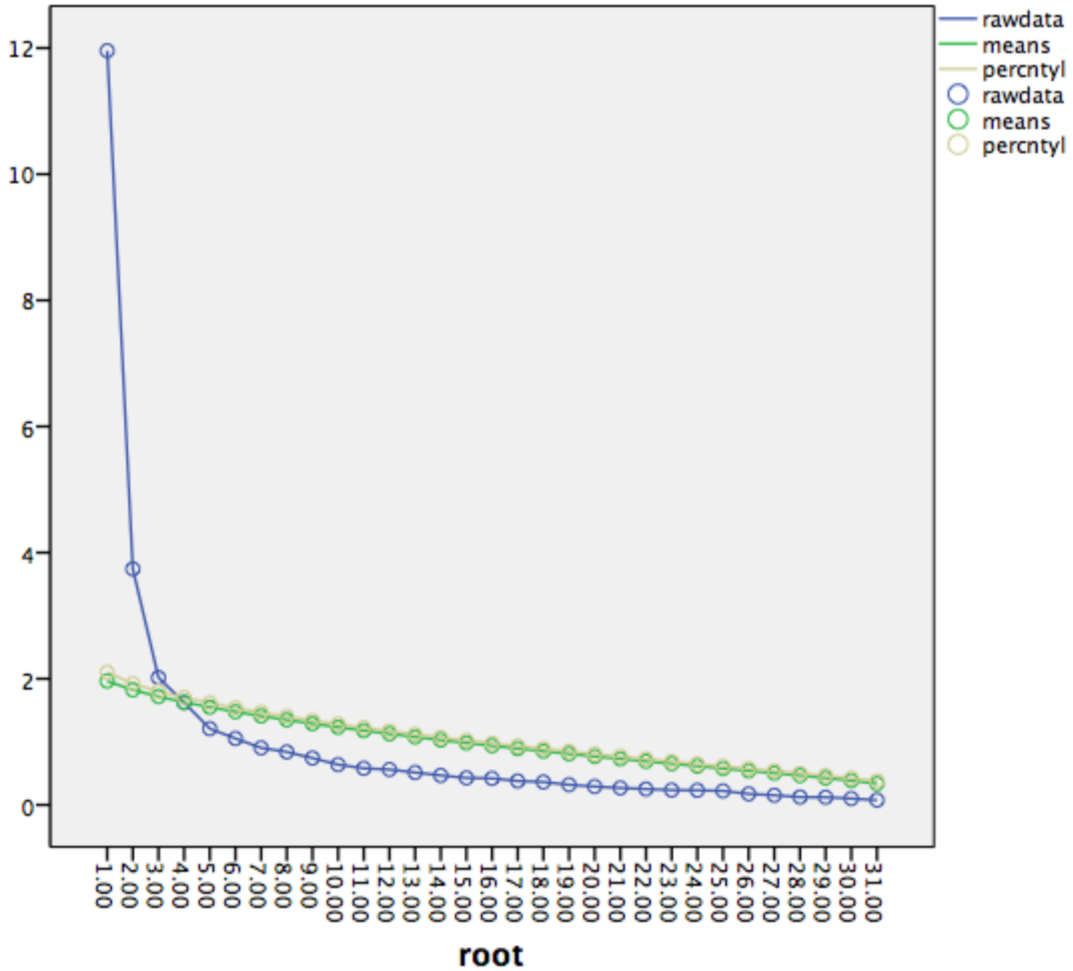

**Figure K.2**

*Preliminary main study: EFA scree plot from rawpar.sps for 23-item attitude section*