Students' perceptions of the benefits and drawbacks of technology during their doctoral studies

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Abstract

Digital competence is increasingly regarded as essential in higher education, particularly since the expansion of remote working following the COVID-19 pandemic, and the introduction of artificial intelligence tools. The impact of digital technology on doctoral students' learning habits and their evaluation of its usefulness remains poorly understood. Using a critical realist ontology combined with a social constructionist epistemological framework, the present mixed-methods study explored whether consistent patterns can be identified behind the perceived beneficial and problematic uses of technology and what relationship these have to academic progress, communication and well-being.

The quantitative phase of the study comprised a cross-sectional survey, conducted between November 2021 and November 2022. This involved an opportunity sample of 310 participants, all doctoral students, recruited predominantly from UK universities. The survey captured data on general software use, emotional reactions to engaging with electronic information sources, data collection, processing and analysis, videoconferencing, communication, training, personal technology use, time management, perceived well-being, rating of study progress, and the effects of the pandemic. Few systematic demographic differences were found although variability in patterns of use, appraisal, and reactions to different tools were evident.

Several factors significantly predicted respondents' perceptions. These were grouped into those directly related to technology use and those concerning well-being. Together, these explained over 25% of the variance, with greater predictive ability in the period when the pandemic was most disruptive. Notably, finding software difficult to learn/use, reported by 12.3% of respondents, was primarily predicted by negative emotional reactions when engaging with information sources. Overall, analyses highlighted inter-relationships between technology use, health, well-being, and emotion. These relationships were situated in a technological eco-system shaped by a set of tools provided by major technology companies and in a biopsychosocial climate shaped by the pandemic.

The qualitative phase of the study employed semi-structured interviews with 16 participants from diverse disciplines. These were intended to illuminate processes of meaning making underpinning doctoral students' technological engagement and to explore, in depth, issues arising from interpretation of the survey data. The interviews were analysed using reflexive thematic analysis. Five themes were developed from the analysis; one overarching theme referred to a pandemic-induced cultural shift in technology use. Three further themes detailed students' evaluation of the technological ecosystem they studied in. These addressed positive and negative aspects of technology use, and the importance of the human element in interactions with technology. The final theme encompassed strategies used to aid well-being by limiting technology use, with a strong emphasis on self-reliance.

Findings from both phases revealed a conflicted relationship with technology. On one hand, technology facilitated social and professional interactions and enhanced efficiency in numerous areas. On the other, developments were associated with heightened distraction, information overload, wasted time, obstructed work, compromised well-being and compulsive patterns of technology use. Together, these tools underpinned a simultaneous strengthening of the means through which students exercised control over their research, alongside a growing sense that personal control was ebbing away, undermined by an unhealthy and compulsive relationship with technology. These paradoxes point to an altered subjectivity at the heart of a transformed socio-technical system that dominates contemporary higher education. Three significant inter-related areas of concern stand out from the findings: doctoral students' difficulties in managing time effectively, their training needs and how these are best addressed, and the challenges posed by artificial intelligence. Running through these issues is the clear importance of the human dimension in understanding individuals' engagement with technology. Study limitations are discussed, concluding with recommendations derived from the findings for improving postgraduate life.

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Author's Declaration

I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

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Chapter 1: Introduction and Research Questions

1.1 Introduction

Technology is derived from the Greek word "techne" to signify art, skill, craft or technique – and in large measure emphasises the practical nature of knowledge (Tabachnick, 2004). In its modern usage it denotes the utilisation of knowledge or tools with the intention to both modify and control the environment (Carroll, 2017), carrying with it elements of novelty and functionality (Burmaoglu et al., 2019). The development of technology has long shaped human life (Stout et al., 2011; Bruun & Walberg, 2022) and, in the present digital age, is understood to be an indispensable aspect of contemporary life, shaping cultural life both inside and outside of higher education (Xiaojuan, 2023; Colamatteo, 2024).

In the modern age, technology structures manufacturing, commerce, telecommunications, social relationships, population surveillance, and transport (Almeida et al., 2022; Kedah, 2023; Wajifi et al., 2023). In particular, within higher education it is embedded within the institutional infrastructure for delivery of course materials, and assessment. Specific technologies also play key roles within distinct disciplines in the construction of disciplinary knowledge. More general technologies are also employed across multiple disciplines and are instrumental not only in accessing literature, collecting data, processing, and analysing data, presenting, and summarising findings but through these means shaping the general course of intellectual labour (Kerimbayev et al., 2025; Bunz, 2025).

In the present thesis, I am concerned with the use and meaning of primarily digital technologies in the lives of doctoral students. Here, I refer to technology in several distinct contexts – functional, situational, and subjective. The functional context denotes the specific software (e.g., for word processing, data processing, videoconferencing etc.) and hardware tools employed to achieve intended goals (e.g. laptops, computers, smartphones). The institutional and socio-technical contexts refer to the institutional and interpersonal domains (e.g., supervision, peer communication) in which technology is situated (Ropohl, 1999), while the subjective context highlights the ways in which doctoral students themselves are changed, for example emotionally or in terms of their identity (Lee et al., 2006; Poletti & Rak, 2014) in the course of using technology during their study.

Competence in information and communication technology has come to play an increasing role in education in recent years, both for students and academic staff (Elzarka, 2012; JISC, 2024). It is now regarded as essential for anyone wishing to enter higher education (HE) (Aspden & Thorpe, 2009; Henderson et al., 2016). To discover innovative and appropriate methods of instruction and learning, universities, especially in the Western world, are rethinking the role of information and communication technology (ICT) in a 21st century environment of accelerating change (Ellis & Goodyear, 2010). The COVID-19 pandemic has also led to rapid changes in technological practice in both education and work life (Vargo et al., 2021;_Watermeyer et al., 2021). Research is needed to examine this role and to understand the impact of technology on students' learning habits and whether this varies between different groups. At present, few studies exist which address students' evaluation of the usefulness of technology. The present study sought to address this gap by examining whether consistent patterns of benefits and drawbacks can be identified in students' use of technology. It further explores whether students' experiences of technology, and their attitudes towards it, are related to how long they have been studying. To this end, two distinct research methodologies were employed to gather data on students' technological use and experiences.

By using mixed methods (Johnson & Onwuegbuzie, 2004), the research aimed to understand in detail both beneficial and unproductive aspects of technology use in postgraduate (PG) study. It can be inferred that how students react to technology may affect their academic progress in significant ways (D'Angelo, 2018). Investigation of how PhD students' academic life is affected can therefore be expected to yield practical benefits for advising current and future students.

With regard to preferences in how academic material is accessed, there is evidence that graduate learners prefer electronic journals over paper copies when writing their dissertation (George et al., 2006; Dange, 2010). This may in part be a consequence of the increased digitisation of resources and the increasing ownership of computing devices. Many PhD students also use popular applications that help with writing, referencing and archiving documents. It is now expected that all PhD scholars utilise technology for their doctoral study. Many can be expected to utilise software applications for researching literature, data analysis and interpretation. It is to be noted that analytic tools are growing both in power and in range. In contrast, other students may use software and hardware which has been explicitly designed for specialist tasks within their own PhD discipline.

Despite the significant contribution of ICT to doctoral learning then, little research evidence is available regarding how doctoral students comprehend its strengths and weaknesses and the effects on well-being which are exerted. This thesis aims to fill this gap using a mixed-methods, explanatory sequential design, which will explore patterns of use and the meanings attendant upon technology use. It is hoped that the findings from the current study can inform new standards of good practice which can then be widely disseminated. It is further hoped that this will permit additional insights to be gained, which will in turn shape how PhD students engage with technology and aid them in its optimal use. Specifically, the study sets out to answer a series of questions.

1.2 Research Questions

The overall research aim is to investigate how technology shapes students' study. The following questions are derived from this.

1. How do doctoral students employ digital technologies to research literature and collect data? Are there systematic differences in how students use and evaluate technology?
2. What perceptions do students have regarding the beneficial and adverse effects of technology on their study tasks?
3. Are there identifiable patterns of technology use in diverse settings that differentiate those who feel productive from those who do not?
4. To what extent does technology facilitate or hinder effective communication with others, including fellow students, teachers, and supervisors? For example, do students prefer face-to-face feedback or feedback mediated through technology?

These are the questions that directed planning of the two phases of the study. Phase one (questionnaire) addressed technology usage patterns, differences between demographic groups, and correlations with perceived study progress. Phase two (interviews) looked in more depth at the underlying meanings and experiences behind technology use.

1.3 Conceptual Framework

The conceptual framework for the present work was based on social constructionism (Burr, 2024). The rationale for this will be discussed in Chapter Four, alongside consideration of the epistemological and ontological basis of the present study. This approach envisages doctoral students as active agents, constructing knowledge in a specific time period – during the global pandemic and its aftermath - in an environment governed by powerful institutions - both higher education institutions, within which the students are situated, and specifically the social media and technology platforms which govern the available means, capability, and forms of interaction available. The nature and patterns of social communication with peers and academic staff, as well as students' interactions with, and analysis of, data, can be viewed as a function of this technological environment. A constructionist approach is appropriate because of the emphasis given to how doctoral students themselves construct meaning around their use of technology, rather than viewing technology as consisting of purely objective properties. The approach permits the social and institutional influences on these constructions to also be considered.

To date, it could be argued that the perspectives of PhD and postgraduate students on the adoption of information and communication technology (ICT) in their study has not been sufficiently addressed. Consequently, the following review draws on literature pertaining to other high level postgraduate programmes, including Doctor of Education (EdD) programmes. On occasion, it will also draw on background material related to other postgraduate qualifications in higher education. This will help to clarify the extent to which findings from students pursuing other higher education qualifications may also be relevant to PhD students.

1.4 Chapter Summary and Overview

This chapter has introduced the nature of the present study, provided a rationale for it and briefly, contextually located the work within a constructionist framework. Chapter Two focuses on the pedagogical issues raised by the technology use of doctoral students in the present period, one marked by enormous economic, technological, social, and political upheaval. Alongside other social institutions, higher education has been no stranger to the changes which have unfolded. Technology has always informed the nature of academic study, the forums in which debate occurs, and the manner and timing of how knowledge is acquired and disseminated. Hence, a review of the histories of doctoral study and distance learning will provide relevant context for understanding the social function of advanced study and its relation to the technological and political currents of the day (Harting & Erthal, 2005). Then, the social nature of the academic community is considered, examining cohort effects, peer learning, mentoring and how these relate to technology use in doctoral education. In Chapter Three, the role of technology training in postgraduate education is considered, along with the use of digital technologies in the ongoing trend toward online doctoral programmes. A number of issues tied to these are discussed. These include the use of social media in education and the effect of the COVID-19 pandemic on technology use in education. In Chapter Four, potential paradigms and methodologies for the current thesis are discussed, concluding with the decision to adopt, within a critical realist ontology, social constructionism as the overarching theoretical framework which will guide interpretation of both the cross-sectional survey and semi-structured interview methods employed. The detailed methods employed in these investigations are presented in Chapter Five. Chapters Six and Seven present and discuss findings from the survey, whilst Chapters Eight and Nine present and discuss the interview findings. Chapter Nine will also bring together the findings from both survey and interviews, with the final Chapter, Ten, considering study limitations, future research and delivering a series of recommendations.

Chapter 2: Pedagogy, Technology, and the Academic Community

This chapter provides a critical review of doctoral education, pedagogy, and technology and its effect on communities of scholarship. Technological innovations over the past four to five decades have profoundly reshaped the experience of postgraduate study. In an information age, regardless of the study discipline, doctoral education is now characterised by the intensive use of information and communication technology (ICT). If we are to understand how students perceive the benefits and challenges of technology, it will require situating these experiences within the broader historical evolution of doctoral education up to the present day. The chapter therefore begins with a brief history of doctoral study, from its origins in Germany to its subsequent organisation and development in the rest of the world. Following this, challenges faced by the traditional model of doctoral study as it enters a technologically transformed higher education landscape will be examined. In addition, this chapter draws on the socio-technical model, which considers the interaction between human behaviour and technological systems, and encompasses such issues as peer learning, social identity and belonging, and the nature of community practice in academic life. These are issues which are central to how doctoral students interpret their lives as scholars in a technologically mediated environment. The aim here therefore is to provide the empirical and conceptual context to the research questions formulated in the previous chapter.

Before discussing these issues in current academic life, it will be useful to review the historical evolution of the PhD to understand the organisational structures and academic processes into which technology has been integrated.

2.1 History of the PhD

The first research-based PhD degrees were awarded by the University of Berlin (then Humboldt University) in 1810. By this time, the existing title of ‘Master’ tied to university teaching had become debased, with a recognition that a higher qualification, which brought with it the right to teach at a university, was now needed (Clark, 2006). Over time, this model spread across Europe, arriving in the UK in 1917 with Oxford University’s first doctoral programme (Bogle, 2018). The impetus for this spread was, in part, political. As Germany began to attract US scholars because of the new qualification, others realised the need for similar incentives to be provided. In the UK, after Oxford, the universities of Manchester, Leeds, Liverpool, and Sheffield duly followed. Over the following three decades the numbers of PhD degrees awarded at UK universities grew from 2,345 in the 1920s to 15,266 by the end of the 1950s (Simpson, 2009). The generation of students now studying for doctoral degrees thus constitutes the latest in a long line. Such historical developments are significant because they have shaped the traditions, expectations, and structures that contemporary doctoral programmes—with their integration with technology—have inherited, although it can be expected that the experiences of contemporary students, due to technological developments, will differ considerably from those of their predecessors.

2.2 Distance Learning

In recent years, the distance-learning student market has expanded considerably (Gilbert, 1996, cited in O'Donoghue et al., 2001) and now comprises a significant part of the student profile in many institutions. Wikeley and Muschamp (2004) have noted how building supportive educational relationships at a distance with doctoral candidates brings its own set of problems. One of these is that students joining a course may have already completed prior Masters' programmes that not only vary in the extent to which theory and practice have been studied but which may also have been delivered face-to-face. The postgraduate experience gained from this may thus be quite different from that acquired in a distance learning framework.

One cannot understand the growth in distance learning without considering the parallel developments in technology and electronic communication. The possibility of instant communication by means of e-mail, virtual learning environments (VLEs) and videoconferencing has encouraged universities to believe that engaging with students at a distance may be an easier and more cost-effective option than traditional face-to-face contact (Masalimova et al., 2022). With the onset of the pandemic, the importance of distance learning has increased exponentially.

2.2.1 Historical Foundations of Distance Learning

The first distance education course, in the sense in which it is now understood – students doing most of their study at a location remote from the centre of learning - was provided by Isaac Pitman in the 1840s (Moore & Kearsley, 2012). By 1858, the University of London had become the first university to offer distance learning degrees (Rothblatt, 1988). These early initiatives played a critical role in opening access to higher education for individuals from underrepresented communities.

2.2.2 Technological Developments and Impacts

These prior initiatives aside, for most people in the UK, distance learning has come to be associated with the Open University (OU). Launched in 1971 on the initiative of the former Labour Prime Minister Harold Wilson, the OU has become synonymous with distant learning and occupies a landmark place in the history of British and global higher education. The university was an integral aspect of Wilson's landmark mission to remake Britain as a nation "forged in the 'white heat' of …scientific revolution" (Francis, 2013). Two competing pedagogical approaches underpinned the OU's offerings – a behaviourist, technocratic approach to the design and development of course materials and a learner-centred approach revolving around occasional face-to-face tutorials and summer schools (Weinbren, 2015). While both approaches have shaped the design and assessment of distance learning (Paul & Tate, 2019), behaviourist pedagogy has been subject to criticism as a basis for doctoral education. Doctoral education, it is argued, needs to rely less on procedural compliance and more on self-directed enquiry and scholarly independence (Bacher et al., 2022).

Since the advent of the COVID-19 pandemic the technocratic side of education has become more prominent, due to the strictures placed on personal social contact. The technological means to deliver teaching and learning remotely has been vital to the continuation of higher education, allowing study and research to be maintained despite the prevailing obstacles. The increased flexibility granted by the technology is beneficial to working professionals and international scholars alike (Brown et al., 2022); whilst reduced peer interaction, digital fatigue, and reduced quality of supervision suggest potential problems which may be flagged by participants in the present study (Hilty et al., 2022). As a result of the successes enjoyed during this period, its role is set to increase (Smith et al., 2022), with Burford et al. (2024) suggesting that the pandemic has acted as an amplifier, propelling doctoral education into a "post-distance" terrain, which in effect blurs any clear-cut distinction between formal online and other doctoral programmes.

The historical and technological backdrop presented above has direct relevance to the present study. Distance learning models have significantly shaped the current organisation of doctoral programmes in higher education, and hence the experiences, opportunities and challenges which participants in this study face will have been indirectly affected by them. It is evident that technological advances supporting distance learning have facilitated wider access to doctoral education. However, it can be argued that this access has been gained without sufficient consideration of the psychological needs of students who may experience isolation and motivational difficulties without the presence of effective support systems (Smith & Jones, 2020). Hence, there remains the question of whether technology is functioning as a tool to fortify social bonds and community building or as a force in higher education which is promoting social isolation.

2.3 The Socio-Technical Model

A major theme throughout this review is the nature of doctoral students' interactions with technology. The question of people's ongoing interaction with technical systems, however, is not a new one, having originated from pioneering work at the Tavistock Institute (Leavitt, 1965; Mumford, 2006, Long, 2018). Socio-technical theory proposes the structure and functioning of any organisational system can be understood through both the human (social) and technical aspects of its operation (Ropohl, 1999; Pasmore et al., 2001). The questions raised by this approach ultimately concern how one can design a 'soft' system where people, the tasks they are required to perform, the structures within which they must perform them, and the technological means at their disposal are in an optimal balance.

From its early incarnation, the socio-technical approach evolved to incorporate modern digital and knowledge-based work environments (Thomas, 2024). Its application in a higher education setting where the primary interest is the management of doctoral students' education in the face of ongoing technological innovation will need to consider the specific cognitive, and socio-cultural aspects of doctoral study. A socio-technical lens situates technology in the context of social practice and highlights the interaction between people, organisational and community structures and technologies (Errey & Liu, 2006), with the histories of both learners and technical systems shaping the interaction. This necessitates a framework in which they are examined collectively (Baxter & Sommerville, 2011). The relevant organisational structures to be considered are often rooted in the workplace policies and practices of higher education institutions (Legemaate et al., 2021), although research in applying a socio-technical systems approach to higher education is relatively scarce (see however Wang, 2010 for an application with respect to distance learning). Of interest are the meeting points between actors (academic staff, doctoral students, librarians, ICT staff) and systems, where obstacles are encountered or seamless transition and change encouraged. Examining the perceptions, understanding, decision making and discoveries of relevant actors, including doctoral students, in this system in relation to the situations they encounter is important. Social-interactions with other technical users may also drive the development of technology use as emergent properties of technical and socio-technical innovations come to the fore, are discussed, appraised, resisted, or utilised (Bauer & Herder, 2009). Modifications in how learners might apply technology have long inspired technological development, an aspect of the socio-historical development of technology itself. This socio-technical framework will inform analysis of data in the current study.

2.4 Language and Information Technology

Language lies at the heart of doctoral education, with spoken and written communication increasingly mediated by ICT, which has had a dramatic influence on the available avenues of academic communication. Intrinsic to this are the linguistic-symbolic tools users employ in their relationships with technology, and which influence how they interact with it and make sense of these interactions. However, several researchers, have noted linguistic confusion when it comes to discussion of information technology itself. Phelps (2002) for example, suggested the concept of ICT was unclear and lacks a precise common definition. While regarded as synonymous with information technology (IT) in some quarters, in others (e.g., Laurillard et al., cited in Balacheff et al., 2009) it is defined as a skill requiring high levels of technical evaluation and understanding. Several authors (Underwood, 2004; Kennedy et al., 2006; Voogt & Knezek, 2008) have argued that failure to utilise a common vocabulary constitutes a limitation in IT and technology-based research, affecting development of evidence-based practice and policy and the identification of training needs. Pretto and Curro (2008) highlighted the confusion, stressing the burgeoning list of terms; from technology-enhanced learning (TEL) to computing, online learning, e-learning, m-learning and blended learning. Moore et al. (2011) commented on the difficulties researchers face when confronted with inconsistent language (e.g., online, distance and e-learning), particularly when they wish to carry out comparative research. The need for an agreed framework to transcend the "relaxed use of terminology" (Moore et al., 2011, p. 129) is now pressing, not least because of the combined pace of technological change and socially induced change in technology use arising from the pandemic. Although researchers generally agree on the problem of inconsistent terminology, there are differing views on the extent to which this hinders research practice (Underwood, 2004) or functions as an obstacle in policy making (Voogt & Knezek, 2008). Nevertheless, this definitional ambiguity may well affect how policy makers, teaching staff and students interpret and adopt technology within the context of postgraduate education.

In the present work, the author will employ the more generic term 'technology' to encompass digital tools, platforms, organisational infrastructure and hardware used to facilitate and administer learning, and educational administration, which has the advantage of having applicability beyond specific applications in data processing.

2.5 Traditional Model of Doctoral Study

The traditional model of doctoral study in universities is premised on the relationship between a master and their apprentice, and the awarding of a PhD is regarded as acknowledgement of successful completion of that apprenticeship. This model first appeared in the natural and applied sciences, where it is customary for research teams to work collectively on a project, with each member responsible for their own contribution to it. In the social sciences, and particularly in education, the model is less common, with students more likely to work on their thesis at an individual level. Their supervisor will tend to be someone with expertise in their general research area but will not necessarily be working on the same project. This makes it a less collaborative venture, although a clear hierarchy still exists between who is the 'master' and who is the 'apprentice.' When the system works well, full-time students will receive appropriate advice and encouragement from their supervisor whilst also being members of the general research community, comprising other students and staff (Leong, 2010; Chugh et al., 2022).While this apprenticeship model has been effective in fostering expertise, it has received criticism for its potential over-reliance on a single supervisor and with it, potentially limited exposure to interdisciplinary perspectives (Smith et al., 2022; Taylor, 2024). Alternative supervisory models have been reviewed by Lee (2008) who compared functional models - oriented around project completion, with those geared toward nurturing critical thinking, self-development and optimal relations with the supervisor. These point to differences in the route to doctoral success (Delamont et al., Parry, 2004), with each approach subject to the varying influence of technology. For example, new modes of collaborative online supervision can be expected to significantly shape the processes of academic socialisation (Gray & Crosta, 2019).

2.6 Community of Practice for Academic Research

Wenger (1998) defined a community of practice (COP) in terms of a group of people who share a common concern, whether this is a set of problems, or an interest in a particular area, and who enhance their knowledge and expertise over time through continued interaction. In the context of doctoral education, this framework offers a useful perspective for capturing the collaborative and developmental nature of scholarly engagement (Khouri, et al., 2017) and can be viewed as consistent with the collective social construction of the academic community. A useful adjunct to the COP framework has been advanced by Rømer (2002), who posited a community of knowledge comprising traditions, curricula, and values, established by means of a specialised vocabulary. The university is well placed to be viewed as a community of practice in that doctoral students absorb academic traditions, follow curricula, and employ a specialised vocabulary handed down through successive generations of academics. It may be assumed that in pursuing a higher degree, doctoral students seek recognition within the academic community and contend with the tensions between knowledge as a commodity and as a public good (Barnacle, 2007).

For a scholarly group to function as a community, there must exist a mutual sense of belonging, fostered by ongoing interaction between research students, peers and staff (Lei et al., 2011; Lewis & Hodges, 2015; Hradsky et al., 2022). One of the aims of the current research is to explore how doctoral students' relationships can be fostered through technology-mediated communication, and whether remote delivery of programmes engenders adverse effects. Community is undoubtedly important. For example, using the community of practice framework in a study of online classrooms, Berry (2017) stressed the importance of a social, cognitive, and pedagogical presence in education, and how, through technology, faculty can create a supportive environment, providing feedback and engagement. Students in the classes reported that this increased the sense of community they experienced and allowed them to use the feedback constructively. A systematic review by Xiaodi, et al. (2024) adds further weight to Berry's conclusions. The review highlighted four effective strategies for promoting meaningful interaction in a collaborative digital learning environment. These were positive promotion, positive feedback, reflection, and technical support. Other researchers point to the importance of friends and colleagues in maximising opportunities and have suggested forms of technology use by students can facilitate a sense of belonging to a digitally connected community (Ang, et al., 2015; Shan & King, 2015).

While some authors have stressed the positive role of technology in furthering community (Ang et al., 2015; Berry, 2017; Xiaodi et al., 2024), others have cautioned against over-reliance on technological tools. Zhu and Procter (2015), for example, pointed to potential disadvantages; problems with motivation and standards, time demands, the possibility for intellectual theft, and lack of understanding on how to sustain engagement with social media. These divergent viewpoints underscore the need for a balanced investigation, which the current study aims to undertake.

An important aspect of academic community membership concerns nurturing of a critical perspective. This embraces two aspects, one concerned with reflection on theoretical foundations, the second, a concern with techniques and protocols (technology) employed in argument and research. These can be considered central to Lave and Wenger's (1998) notion of a community of practice. In the present context it also entails a potentially critical attitude to the functions and consequences of technology use, including potential criticism of the availability and distribution of technological tools.

Critique then can be considered a discursive practice within the COP framework (Crossley & Holmes, 2001), and is closely related to Nicoll's (2002, p.398) definition of scholarship as engagement in "the collective generation of knowledge." Such discursive, critical endeavour can be considered the key element of any research degree. Only when a student employs theory, methodology and critique collectively, to develop a shared, socially constructed practice can they be judged rightful members of the academic research community (Wikeley & Muschamp, 2004). This critical perspective is vital for how students and practitioners consider technology use. For example, in some areas of science and social science, the complexity of some forms of data preparation and analysis, for example genetic sequencing, neural imaging or advanced statistical procedures, can result in an uncritical acceptance of interpretations which have been applied to data. This has contributed in part to the crisis in replication which has emerged in recent years (Cooper, 2018; Zwanenburg, 2019). In studying postgraduate students' relationships with technology, the research sought to find expression of both positive and critical views toward it. A further issue in this context is how technology itself can function, not only to augment and encourage critical thought but also to narrow opinion and reinforce extremist opinion (Su et al., 2022).

Communities of practice thus enable insight into the social means by which doctoral students and supervisors construct knowledge together in formal and informal settings. In acknowledging the role of technology in this, it can be considered in conjunction with the socio-technical model. The emphasis on learning from *social* interactions aided by technology leads to an examination of the influence of cohorts.

2.6.1 The influence of cohorts on online doctorate technology

It has been suggested that belonging to a cohort increases a student's chances of programme completion, through facilitating a sense of community, structure, and cohesion (Berry, 2017; Tinto, 1993). Shulman (2010) called for the practice of cohorts in professional doctoral programmes to be normalised as they enable candidates to integrate academically and socially throughout their programmes. Bista and Cox (2014) found cohort models facilitate easier faculty and peer engagement as well as increasing students' satisfaction with their interactions. Further research has found that students not in cohorts are less likely to engage with peers and tend to engage with others only in small numbers (Garrison & Arbaugh, 2007; Moore, 1989; Terrell et al., 2009). Peer connectedness, meanwhile, may improve both persistence and integration into a study programme (Lovitts, 2001; Rovai, 2003).

A cohort in doctoral programmes has been defined by Lei et al. (2011, pp. 497-498) as comprising "a group of about 10-25 students who begin a programme of study together, proceed…through a series of developmental experiences…and end…at approximately the same time." Cohort members may experience it as providing support from peers and faculty (Biesta, 2009). Social interaction within cohorts can be direct or mediated online via technology (Rockinson-Szapkiw et al., 2019). In a study of 278 current and former doctoral students in education, a high degree of comfort with technology and online systems has been linked to persistence (Ivankova & Stick, 2007), and, in addition, facilitated students feeling like they were completing a residential programme.

The importance of building relationships, mutual support and community in online courses has been shown in several studies into the effect of cohorts on doctoral study completion – with findings showing online EdD candidates experiencing greater programme integration in cohorts (Liechty, et al., 2009; Shacham & Od-Cohen, 2009; Bhandari et al., 2013; Rockinson-Szapkiw et al., 2019). Studebaker and Curtis (2021), for example, found success in an online EdD programme was associated with success in belonging to a community where understanding of the isolation and challenges of an online doctorate helped postgraduates to sustain motivation. The three main community-related factors to which participants attributed their success were 'cohorts' 'consistency and intentionality' and 'connections'. While positive outcomes associated with online cohorts have been demonstrated, much of the work has focused on US based EdD programmes and may have limited generalisability to other cohorts. Nevertheless, Studebaker and Curtis (2021) recommended educators delivering doctoral programmes receive instruction in a cohort model that enables a cohesive community to be created even when programme participants are situated in different locations and time zones.

2.6.2 Role of Peer Learning amongst PhD students

The first place where doctoral students have an opportunity to develop a sense of being members of a pedagogical community is with their peers. The concept of peer learning has roots in socio-cultural and social constructionist theory; both conceptually linked to Vygotsky's (1962) work. He proposed a zone of proximal development, in which co-operation with more skilled peers can enable learners to construct a higher level of knowledge and ability. The existence of an established academic community of practice (Lave & Wenger, 1998) creates a particular space for students where they can develop their understanding and practice to a level where they can assume responsibility for their own learning (Tharp & Gallimore, 1994). This also provides a framework for analysing the processes by which doctoral students come to develop their own voice and identity. This issue of autonomy has perhaps assumed greater importance since the onset of the pandemic.

Evidence from a recent systematic review by Pointon-Haas et al. (2023) suggested peer learning and mentoring significantly reduce anxiety and stress. This concurs with earlier work that feeling connected with peers is beneficial to persistence and mental health (Devlin & McKay, 2017). Evidence for the beneficial effects of peer learning on persistence has also been found in a recent survey of PhD programmes (UKCGE, 2022) which reported structured peer learning groups may reduce attrition by up to 14%. An undoubted advantage of peer learning is the benefit afforded to part-time scholars, who tend to be more socially isolated (Deem & Brehony 2000; Zahl 2015). Furthermore, it can assist scholars in professional doctorates, by allowing them to develop relationships which foster professional integrity together with both disciplinary and individual experience (Wellington & Sikes 2006; Pratt et al., 2015).

Meschitti (2019) examined the dynamics of peer learning amongst a group of PhD students in a Swiss computer science department. She described how three different types of interaction - learning and practising scholarly skills, learning new methods, and scaffolding, can each contribute to the development of knowledge and skills. Active participation, shared discussion and practical co-engagement in activities were found to be crucial to improvement. Meschitti also discussed the importance of the emotional aspects of scholars' interaction and how forward planning regarding the use of social space was integral to its success. Overall, this provides a promising model for the acquisition and development, not only of technological knowledge, but also of how the learning of technological skills can be organised as a social rather than individual activity. These potentially positive effects notwithstanding, peer learning may also have negative effects. There may be unequal participation by group members, with added risk that incorrect information may be passed on by more forceful, influential individuals.

There is undoubted potential for technology to assist in peer learning, not least because of the more informal nature of peer relationships compared to those with academic staff, and the multiple technological platforms through which they may be conducted (Lee & Bonk, 2016). Again, the current study gives participants an opportunity to comment on and discuss these matters and intends to highlight both the social and emotional potential of technology in overcoming isolation and enabling collaboration. In employing a mixed-methods approach, it explores the prevalence of perceived benefits and challenges, and through interviews assesses the nuanced meanings through which doctoral students navigate their relationships with peers and academic staff in technology-mediated environments.

2.7 Learning to Become a Member of the Academic Research Community

The journey to recognised membership of the academic community can be viewed as a learning endeavour dependent on social relationships with key others. Important activities in this 'academic socialisation' may include authorship or co-authorship of papers, applying for grants, contribution to peer review mechanisms, and membership of professional bodies. Technology can be used to foster these activities and to aid communication in academic settings – notably where distance is a problem. Chatrooms or WhatsApp groups involving purely text-based exchanges offer a means by which students can be encouraged to build trust and take risks in their learning. Open dialogue, if pursued, can make possible a shared understanding and collective generation of new ideas and knowledge (Wikeley &

Muschamp, 2004). Chatrooms provide a forum for "trying things out," and debating with others prior to views being circulated in writing to others in more formal settings.

Regular online interactions can enable the formation of virtual communities, with collaborative web-based workspaces to share material and enable discourse (Ivankova & Stick, 2007; Rockinson-Szapkiw, 2011). However, virtual communities may also have problems. Lovitts (2001) for example, found isolation was frequently cited and virtual communities may be limited in the degree of informal contact that can be offered – with this being an important avenue for networking in traditional spaces. In response, Chang and Bryan (2020) argue that it is imperative for distance education programmes to have purposeful support systems in place that foster connectedness and integration. Nevertheless, any move by doctoral students toward active engagement with the academic research community is congruent with Wenger's (1998) account of communities of practice, where doctoral students increasingly take on more central roles as their knowledge accumulates.

With many commentators now mindful of the strategic importance of online learning (Bayne, et al., 2014; Allen et al., 2016), it is vital that social as well as demographic aspects of learning and their relationship to student retention are considered. Understanding the dynamics and opportunity for social connectedness in the technological realm is important (Baym, 2009) and has grown in the aftermath of the COVID-19 pandemic. Given the speed and recency of technological developments in education, the need for research on diverse populations to improve the generalisability of findings across non-STEM and STEM online programmes and PhD programmes is also needed (Rockinson-Szapkiw et al., 2019). The current study examined the role of technology in regard to the social connectedness of PhD students from a variety of academic disciplines.

To date, a variety of research methodologies has been employed examining the role of technology in this journey. Each has shed light on different aspects of the challenges. Case studies for example (de Valero, 2001; RIN, 2010), have examined training, supervision, teaching, and research in the context of common technologies (e.g., email, online courses and digital library resources). Other research (e.g., Smith et al., 2003; Lynch, et al., 2018; Bailey, 2019; Hands, 2020; Zhang et al., 2020) has utilised survey methodology and has assessed candidates' online readiness, motivations, development, and academic growth. Finally, interviews and focus groups (Turney & Pocknee, 2004; Zhang et al., 2020) have been used to assess research students' views of Blackboard, the online virtual study environment. All the methods have yielded important information about issues which must be faced in becoming a member of an academic community.

The collective generation of knowledge by the academic community is a pedagogical issue of great significance. It is realisable through challenging ideas, arguments, and theories with tutors and fellow students. This remains the case even when the parties cannot be physically present together, hence the mediating role technology can play. The importance of this during the pandemic and its aftermath has been considerable, thus one of the aims of the current research is to examine this. The process, however, is not culturally universal. In East Asian doctoral education, for example, senior-junior teams and formal mentorship networks are more prominent than in Western contexts and provide a typical route for access into the academic community, offering a similarly effective if more hierarchical integration process (Shin, et al., 2018). Access to the academy is furthermore not necessarily straightforward. Structural barriers can impede entry, with students from minority groups experiencing significant obstacles (Sotiropoulou, 2022; Mateos-González & Wakeling, 2022), affecting whose voices are heard and valued.

However, achieved, successful integration into the academic community is critical both for individual careers and for future identity as an academic. For those already employed, established networks can open doors to greater opportunities, visibility, and competitiveness for academic appointments. With that said we now turn to the question of identity positioning amongst doctoral students and how technology may facilitate that.

2.8 Identity Positioning among Doctoral Students

In doctoral study, identity positioning refers to how an individual positions themselves and is positioned by others within the cultural landscape of academia (Gee, 2000). As such, it encompasses both self-ascribed identities and those ascribed by others. As suggested earlier, technology may assist PhD students in developing their voice and identity. Since use of the Internet, and in particular social media, has mushroomed, students have turned to websites and social media profiles to reflect, develop, and construct their identities. The relationship between the doctoral student and the supervisor may also contribute to identity positioning through feedback, ongoing support, and encouragement (Bao et al., 2025). In acknowledging the role of social media, Sanchez-Holgado et al. (2021) have called for recognition of its potential to spread scientific progress.

Empirically, Facebook appears to be the most popular platform for science dissemination, closely followed by Twitter/X (Sanchez-Holgado et al., 2021). Recent estimates suggest Facebook has more than 3 billion monthly visitors (Statista, 2025) and can be expected to be a preferred platform for PhD candidates, seeking to reach more general audiences and establish a digital identity and greater academic visibility (Alperin et al., 2019).

Greater online visibility means that messages conveyed in social media can swiftly attract attention and engagement. In this respect, constructing an online identity can resemble forms of commercial advertising. The potential impact of a research paper is multiplied by social media, raising the number of academics who are aware of it, and thus increasing the possibility of it being cited - a key performance indicator. Digital identity denotes both the researcher's impact and visibility and in what contexts that visibility is present. Drawing on the Unified Theory of Adoption and Use of Technologies (UTAUT) model (Venkatesh et al., 2003; Xu et al., 2024), Sanchez-Holgado et al. (2021) suggested several factors may influence how much a given technology is used. These include the setting in which it is found, the potential of that setting to promote social influence, the effort entailed by its use, and the expected future rewards arising from its use.

In relation to digital identity construction, Gergen's (2000) work is suggestive of how interaction with different social media enables multiple ways for identity to be performed and conveyed - including blogs, peer-reviewed journals, Twitter/X and on-line conferencing. How students position themselves (e.g., as experts, or peripheral participants) and how identity is expressed may differ between these, as it is not constructed simply by a diverse set of narratives, but also in response to the different social media environments and people one finds there.

Some insight into how the process of identity formation evolves through time comes from Bennett and Folley (2014) who analysed, over a five-year period, the experiences of two doctoral candidates who used social media devices in their research. The students recounted their own experiences to convey the way their hybridised identity - as PhD candidates and faculty members at a UK university – developed over time and influenced their membership of online communities. This led the authors to view the PhD process as a voyage of identity creation, a non-linear trajectory moving between periods of confidence and uncertainty, which was in part supported by social media. Bennett and Folley (2014) contend that a decision to employ social media requires a student to generate a research-related online identity, which can become increasingly complex over time. This journey, mediated through social media, may entail both positive and negative aspects, with students finding the medium can potentially provide respite from the isolation and seriousness of study, whilst also aggravating anxiety, and self-doubt. There is no doubt that online spaces can be ambiguous and difficult to handle. In Mewburn's (2011) analysis, online environments such as Twitter and blogs enable the management, performance, display, and control of emotional responses which arise from the demands of doctoral research. Lantz-Andersson, et al.'s (2013) observations echo those of Winter et al. (2010) who found graduate students in online educational settings frequently flipped between learning and non-learning practices, revealing a tension between using social media for work and for pleasure (Leon & Pigg, 2011).

In considering the psychodynamics of peer interaction, Meschitti (2019) noted a major aspect of these concerned how learners saw themselves. For distance learning doctoral students in online networked-learning settings, how they positioned themselves traversed many aspects of their lives - social, intimate, cohort, academic, departmental and professional. Participants' stories called attention to how they handled their relations through degrees of sharing, withdrawing, prioritizing, rationalizing, and changing practices, leading to an evolving set of technologically assisted habits building new social relations (Koole & Stack, 2016).

PhD students, positioning themselves in different areas of their lives, contend with a potentially confusing combination of identities. Bennett and Folley (2014) also noted how social media can create specific difficulties in conveying identity to diverse audiences, each of which may view them differently. PhD candidates may also choose to elaborate their identity through blogs as well as personal websites, which can be referenced and linked to established platforms such as Facebook, Skype, and Twitter/X. In addition to promoting academic identity and strengthening social relationships (Llorens & Capdeffero, 2011) these can contribute to learning outcomes via the provision of information (Junco et al., 2013).

The use of technology to develop a researcher's identity can be seen as particularly important during the pandemic, a time when normal social engagement was restricted with students particularly reliant on technology to develop their voice and identity, through social media, online forums, and support groups (Elmer et al., 2020). The extent to which students were still engaging in these strategies and their perceptions of the benefits and challenges which come from this engagement was explored in the current study, alongside investigating the emotional ecology of online spaces for today's PhD students, particularly in the light of COVID-19.

While the end result of the socialisation process –successful acquisition and recognition by others of one's academic identity - has not been discussed here, it is important to acknowledge how identity positioning can be adversely affected by the overall climate within which higher education functions. For example, the neoliberal restructuring of universities might give undue emphasis to aspects of academic identity which are constructed in terms of performativity and measurable outputs, irrespective of actual quality, rather than genuine scholarly endeavour and critical thinking (Giroux, 2016).

2.9 Mentoring

Supervision has been considered by some researchers (e.g., Schockett & Haring-Hidore, 1985; Anderson & Shannon, 1988; Welsch, 1996; Zuckerman, 2001; Fitzpatrick, et al., 2006) as a nurturing process, akin to mentoring, in which a student is tutored, supported, counselled, befriended, and encouraged, in doing so promoting and enabling academic and personal development. Such support has been shown to be beneficial for doctoral candidates' self-efficacy (Hollingsworth & Fassinger, 2002; Overall et al., 2011), and their development of professional skills and academic socialisation (Mullen & Forbes, 2000). It has also been related to student satisfaction, enhanced well-being and academic success (Heath, 2002; Zhao et al., 2007, Harris & Lee, 2019). This may be distinguished from traditional supervision by the greater relational emphasis, and attention to longer-term goals beyond thesis completion. The importance of caring relationships with doctoral students and how these may facilitate socio-emotional skills, academic identity and academic success has been documented in several studies (Akoji et al., 2019; Rogers-Shaw & Carr-Chellman, 2018).

Ascertaining the intended career paths and personal objectives of doctoral candidates as well as the issues which affect their career choices could be considered a prerequisite to such nurturing and potentially help supervisors offer greater support. This may be important as candidates modify their goals over the course of their studies (Golde & Dore, 2001; Hoskins & Goldberg, 2005). Fuhrmann et al. (2011) for example, found that one-third of doctoral candidates in biomedical sciences had amended their career ambitions, switching from a research-focused career to a non-research-based one. These shifting aims may relate to the degree of confidence candidates experience throughout their development as well as their perception of the academic environment and their own marketability. Zhang et al. (2020) observed how confidence declined as candidates progressed from the first to the second and third years of their doctoral studies.

Specific kinds of support and mentoring may be needed for students whose training lies in specific areas of professional skills or technology use. The extent to which such mentoring relationships flourish in a technologically mediated learning and support environment will be considered next.

2.9.1 Technology and Mentoring

Academic mentoring is increasingly being reshaped by technological advances, in which virtual spaces, collaborative digital workplaces, and virtual scholarly networks are being enlisted to provide support. It has been suggested that online mentoring of doctoral students can be achieved by advisors being open to dialogue through multiple technologies and by the provision of structure (Kumar et al., 2013). Together these may reduce 'transactional distance' (Moore, 1993), in a similar way to the student-teacher interactions required for successful online courses. Kumar et al. additionally suggested that increasing learners' autonomy and sense of ownership over the work they do is important. Whatever strategy is followed, the importance of flexibility in how communication and dialogue are promoted is essential.

A review by Maor et al. (2015) suggested doctoral supervision could be improved using technology, with web 2.0 tools – which emphasise user generated content - facilitating dialogue and collaboration between students and their mentors. They believe an accessible and user-friendly web-based supervision tool is required, able to incorporate online and face-to-face discussion spaces, and provide collaborative writing. Maor et al.'s study provides an example of how relationships between students and mentors may be supported by technology and potentially offers a means for reducing the dropout rate for doctoral students. Supporting evidence for this was obtained by Maul et al. (2018) who found doctoral students coached via videoconferencing (Zoom) during their dissertation writing period demonstrated increased self-efficacy and efficiency and were less likely to drop out of their course. Mentoring and other relationships which encourage students' self-belief, may therefore be a critical factor in reducing drop-out, with technology potentially having an important role in fostering these relationships and allowing them to be strengthened. In appraising the capacity of technology to bolster relationships and facilitate support to doctoral students, many influences must be considered. A qualitative study by Thompson et al. (2018) into the effect of learner interactions - with course content, instructor and other learners - on online learning success, highlighted the importance of engaging students in meaningful learning activities, alongside active faculty engagement, with both contributing to doctoral student performance. The current study can be expected to cast further light on this through students' accounts of the beneficial aspects of technology use and their specific use of technology for academic social interaction and communication.

In their review of doctoral education and online learning Deshpande (2017) identified supportive mentoring to students as one of five themes associated with effective doctoral research. Others were providing ongoing support and endorsing peer-to-peer facilitation; bringing together new and experienced staff; the development of sensitivity to cultural matters and providing good-quality feedback. All the themes can be considered psychosocial in nature and emphasise the role of interpersonal issues in successful doctoral education.

Kumar and Johnson (2017) investigated online mentoring during the dissertation writing component of an online doctoral programme. The study suggested mentoring in small groups with a peer support component helped to overcome difficulties with distance learning and online communication. As this programme was conducted entirely online however, it is possible that the students who enrolled were more comfortable with technology than is the case for a typical doctoral student. The generalisability of these findings to other campus-based doctoral programmes which might have proceeded during and since the COVID-19 pandemic, is thus uncertain.

2.9.2 Feedback in Mentoring

The importance of feedback in any overall support receives further backing from Odo and Youngjoo (2014). They suggest international doctoral students could use videoconferencing for receiving online feedback on writing. One benefit of this over other asynchronous modality, such as email, they suggested, is that feedback given is instant, permitting participants to immediately engage in discussion to check their understanding. Students also suggested that communicating by means of videoconferencing reduced feelings of physical distance between themselves and their mentors.

Although the increasing utilisation of technology-based feedback as an alternative to face-to-face feedback has been noted prior to the pandemic (Cheng et al., 2015), relatively little comparative literature exists on the way both are used in academic writing. In a rare example, Liu et al. (2021) used interviews, peer feedback and class assignments to compare electronic feedback produced on WeChat, Rain, Classroom and Moodle, with face-to-face feedback employed at various stages of writing. They also considered how these types of feedback influenced students' help-seeking and self-efficacy. The authors suggested the organisation of feedback could be grouped into three stages: initial face-to-face feedback for the purpose of giving encouragement, followed by e-feedback from peers providing detailed, constructive feedback and finally, detailed face-to-face feedback among group members. They contend that these different types of feedback can have distinctive benefits in overcoming cultural hurdles and can improve writing self-efficacy and proactive help-seeking. In an earlier work, Caffarella and Barnett (2000) found that receiving and providing criticism face-to-face, enabled doctoral candidates to improve their writing quality as well as understanding of academic writing and the value attached to being a writer.

An investigation of technologically mediated mentoring (e-mentoring) in an online professional doctorate programme found it was well received, with over 75% of participants reporting satisfaction with both peer-to-peer and faculty-to-student mentoring (Jacobs et al., 2015). This research suggests e-mentoring can provide opportunities for social interaction not expected in an online environment. With postgraduate study unlikely to return to something approaching pre-pandemic norms in the foreseeable future, such e-mentoring may become a practical model and warrants scrutiny.

In a somewhat different approach, both Stark and Crawford (2015) and Wilson and Brewster (2017), found use of emojis could reduce tension induced by negative feedback - showing not only that technology may allow students to overcome difficulties associated with negative face-to-face feedback, but also that mixed modality feedback can offer advantages. In a further use of emojis, Liu et al. (2021) found that, when accompanying e-text feedback, they helped doctoral candidates to perceive the input as more authentic by circumventing the psychological obstacles frequently present in conventional face-to-face settings. Feedback can of course have multiple effects. Positive peer feedback may seed motivation and confidence (Gómez-Miñambres, 2012) as doctoral students receive validation from peers and become aware of the fulfilment of goals, whilst negative feedback, if constructively provided by peers, can lead them to extensively revise their writing and self-regulate their learning (Kumar & Stracke, 2007).

With increasing numbers participating in online doctoral programmes, and particularly the growth in international learners, it is increasingly important for academic staff to consider the cultural backgrounds and research capabilities of learners when providing developmental support and supportive feedback (Le & Gardner, 2010; Ma & Schoeneman, 1997). The current study was sensitive to students' perception of feedback and the avenues through which they may receive it.

2.9.3 Mentoring and the Pandemic

Mullen's (2021) investigation of the transition to online doctoral mentoring following the pandemic is of particular interest. During the mentoring intervention, participants interacted with a faculty member on a one-to-one basis, both synchronously and asynchronously, with technology utilised to provide feedback on drafts using change-tracking software, with questions answered either by email or through Zoom meetings. Social well-being was also considered. Feedback from students suggested the intervention was effective in reducing pandemic-induced disruption. Several factors were identified as helpful in this: feedback from mentors, organisation of individualised sessions, scheduled appointments and efficient use of technology. The study was conducted in the US; whether comparable use of technology exists outside the US cannot be assumed.

2.9.4 Mentoring – Overview

The importance of good-quality communication between students and mentors has been a focus in higher education research. The research reviewed suggests doctoral candidates' progression into membership of the academic community can be aided by mentoring, with evidence that good mentoring relationships can be fostered by technology. The process of technologically assisted mentoring can be accommodated within a situated learning framework (Auer & Tsiatsos, 2019). Originally proposed by McLellan (1996), the framework comprises several aspects: coaching/mentoring, a collaborative cognitive apprenticeship, feedback, reflection, and multiple forms of practice, all of which feature in the design of doctoral programmes. The emphasis on context and culture in situated learning requires that the socio-technical educational environment be considered a key aspect of culture. This includes all aspects of technologically mediated social interaction, including via emails, social media, texting, and videoconferencing (Errey & Liu, 2006; Baxter & Sommerville, 2011; Skierkowski & Wood, 2012; Nistor et al., 2014; Lisa & Paula, 2015).

Despite the benefits associated with mentoring, the process is far from simple. Potential pitfalls include excessive dependence on the mentor, unclear expectations of roles and responsibilities, and variability in the quality of mentoring relationships, which may be dependent on the mentor's experience. These issues may disproportionately affect international, minority, or part-time doctoral students (Lee et al., 2023; Chen, 2023; Wisker, 2023).

As developments in doctoral learning continue at speed, the fusion of established mentoring skills with new digital methods constitutes a radical change in practice. This transformation is explored in the next chapter, where the function of digital technology in doctoral education as a whole is considered.

Chapter 3: Digital Technology in Doctoral Education

3.1 Technological Training of Doctoral Students

In higher education, there is increasing demand that institutions improve the range of digital skills students can acquire. Universities are now subject to market pressure to improve their comparative standings with other institutions, to recruit more graduates, to promote access to higher education and to offer good employment prospects on graduating. A consequence of this recruitment drive is that first-generation postgraduates may require enhanced support to help them continue their studies, as students who are challenged by technology may be more likely to drop out (Pascarella et al. 2004; Pratt et al. 2019; Cataldi et al. 2018). Technology training can therefore be viewed as an important element of doctoral education, equipping students with digital competencies to enable them to conduct research at the highest level, present findings and network within the academic community. Appropriate training can encompass basic digital literacy (e.g. database searching and citation tools), tools for conducting research (e.g., SPSS, NVivo, data visualisation), videoconferencing and communication tools, (e.g., Zoom, Teams, social media) and emerging technologies such as ChatGPT and open science platforms.

Within both a UK and wider international context, doctoral training requirements frame digital literacy as a significant component of a researcher's development, recognising that it is not only disciplinary expertise which is desired but also the ability to work with digital technologies in order to enhance research productivity, and impact (Smith McGloin & Wynne, 2022; Taylor, et al., 2025).

Although research into access to higher education has often focused on undergraduates, postgraduates are more likely to have prior technological experience and thereby different training needs (VanDer Schaaf & Shifrer, 2019). Further thought is thus required regarding how students' needs differ because of their prior experiences, and/or unequal access to training, which may be linked with gender, or other socio-demographic markers (Beetham & White, 2013). One such demographic, and one of considerable importance in contemporary higher education, is the part-time status of students – (of which the current researcher is one) the numbers of which continue to grow (Gardner & Gopaul, 2012). The most recently available figures from Universities UK (2023) have put the proportion of part-time students in postgraduate education at 34%. Despite this, most doctoral programmes are created for full-timers. Zhang et al.'s (2020) study of 98 doctoral candidates, demonstrated how pathways toward academic growth differ for those in full-time and part-time study. These pathways can be shaped by the fact that part-timers tend to report greater isolation and long-term stress (Watts, 2008; Limarutti, et al., 2023). Given this isolation, how part-timers develop an academic 'identity' and how this relates to their vocational ambitions may well differ from full-timers and be more dependent on e-mentoring and peer mentoring.

With this diversity in experience of students with different technological needs, a neglected, though important issue, is how technology designers imagine the capabilities of the users of their systems and how this affects the implementation of their designs. How and when doctoral students first encounter particular forms of technology and acquire relevant skills in its use is an important question. Lim et al. (2020) proposed that technological tools, including academic tools such as Endnote, and general tools such as Google Docs, should be introduced early in doctoral training to enable more effective use of technology throughout students' research careers.

The pandemic has meant that many learning tools have moved quickly into the academic mainstream, with contacts between students and supervisors now frequently technologically mediated. Bishop-Monroe (2021) found web-based training programmes during COVID-19 facilitated increased confidence and competence in doctoral students. In the UK there is evidence that digital skills courses have benefited academic progress and doctoral students' employability (UKCGE, 2022). However, it is unclear how widespread such training is, a question which the current research addresses. Gouseti's (2017) pre-pandemic analysis of 12 interviews suggested training given to doctoral students is limited, covering narrow areas such as data collection, analysis and referencing. Gouseti also noted that training in other areas of importance to early career researchers, such as engaging in online research communities and creating an online presence, were largely overlooked and that students lacking previous experience with technology were more anxious and less confident than their peers. The need for training to develop skills is thus evident (Gousetti, 2017; Leshchenko et al., 2021).

3.1.1 Role of Librarians in Training

In exploring the strategies and technology students use at different stages of their doctoral studies, Cushing and Dumbleton (2017) contend that they be encouraged early on to develop understanding of how to evaluate the tools at their disposal. At the mid-point of students' studies, librarians could also provide training in how to use selected tools, and encourage good practice, for example backing up data. The relationship with significant others, such as librarians, may thus have a crucial role in doctoral training, with Alotaibi and Johnson (2020) calling for further study on the influence of university libraries and their support services on students' perceptions and skills.

In their own study Alotaibi and Johnson (2020) sought to enlist librarians for two main purposes. First, to promote new information resources to graduate students and second, for librarians to consider modifications to university library websites, so that they are developed with users' perceptions of their usefulness and ease of use in mind. The present study similarly has the potential to inform the development of new training and resources which could improve doctoral students' experience of education and address gaps in their understanding.

With global digitalisation leading to increasing reliance on technology, there are indications that librarians in British universities are assuming the role of training doctoral students in digital literacy and skills (Soltovets et al., 2020; JJISC, 2024). Popular topics include information searches, evaluating sources and data, in addition to referencing, planning research and citing literature. However, issues such as avoiding plagiarism and malpractice, as well as acknowledging copyright continue to evoke uncertainty. In fact, the use of technology in information searching by graduate students has been an important theme in the library literature for the past two decades (Moore & Singley, 2019). Much of this research has focused on the way graduate students engaged with the movement from print to digital sources and how this shift has influenced library engagement. A review by Ince et al. (2018) identified training in information literacy, information management, knowledge management and scholarly communication as important components of doctoral research. They recommended teaching by library staff with continued personal development in these areas.

Technologies related to doctoral students' own subject areas and field of professional development tend not to be facilitated by library staff. It can be hoped that this is taught by the supervisor. The question of training and where it is acquired will be assessed in the current work.

3.1.2 Self-Training

Several studies have examined the usefulness of mobile learning devices, so called 'm-learning' (Ng et al., 2020). In the context of distance learning PhD students, Cotter et al. (2015) found the devices contributed to improved motivation and productivity. The actual device used was also relevant, with perceived usefulness increasing as the technology became more advanced. This may be a consequence of the increasing ability of technology to facilitate participation in online discussion and synchronous interaction (e.g., through email, audio or video conferencing).

Despite the positive implications of the above work, some doctoral students may lack knowledge of the potentialities of e-learning and m-learning. A study of 50 doctoral students by Mireles' et al. (2018) found the vast majority had been largely self-taught; as a result, they were unaware of ways in which mobile phones and ICT could be used to further their educational goals. It was suggested that although all the students had access to ICT and a mobile phone, only 4% used the phone innovatively, whilst 14% used little technology for their education. Tsatsou's (2016) work also pointed to low levels of formal training and a reliance on being self-taught. She interviewed nineteen researchers across the social sciences and humanities, documenting those who had received specific training in digital skills, against others who had acquired their knowledge through skill-sharing with others or self-teaching. Despite the low levels of formal training, most of those interviewed believed they already possessed sufficient digital knowledge and skills. Some of the participants believed training in technology is more important within the humanities than sciences, owing to the belief that research scientists would be more likely to have already acquired relevant skills during their undergraduate studies. The extent to which discipline-specific technology education is needed for doctoral students remains unclear. Tsatsou's work also suggested that different technologies are employed at different stages of the research process. Overall, emails, videoconferencing, online repositories and file sharing systems were the technologies most frequently employed. Finally, one view, widely expressed, was that many research activities did not require a high level of digital proficiency – a possible consequence of existing informal learning - although it is also possible that students' perceptions of their need for training does not align with their actual need. The absence of formal training must also be considered a potential factor in the relative isolation experienced by doctoral students (Gouseti, 2017).

3.1.3 Problematic Issues in Training

An early study by Song et al. (2004) identified several issues that could potentially impede the success of on-line learning and training and which remain relevant today. These include technical issues, an absence of community, insufficient time and badly communicated course details. Song's observations have been reinforced more recently by Woo et al. (2021) who drew attention to how online/hybrid courses can suffer from a lack of in-depth communication between students and instructors. Woo et al. believe that the training of instructors prior to teaching such courses may equip them with the knowledge and understanding required to run them more successfully. Such teaching support has been identified as a strong mediating factor in promoting teaching innovation and satisfaction in online environments (Han, Gao & Yang, 2021). The recent JISC (2024) survey also points to the importance of technical difficulties (lack of suitable devices, inability to access systems, connectivity). With relatively little research conducted on training, the present study will investigate how students view any training they have had and the training they desire in the course of their postgraduate study.

3.2 Artificial Intelligence

3.2.1 Relevance of Artificial Intelligence

The term 'artificial intelligence' (AI) refers to computational processes that possess the ability to perform tasks usually considered to require human intelligence, for example, learning, reasoning, problem solving, and use of natural language (Eysenck & Eysenck, 2021). AI tools have been present for some time in computing environments (Bozkurt et al., 2021). Existing web-based search engines such as Google are in fact an example (Yuniarthe, 2017). The higher education technological ecosystem is, however, now facing novel challenges stemming from the development and introduction of the latest generation of AI tools, not least in relation to the integrity of assessed work (Landers, 2024). The use of large language models, such as ChatGPT, considered a specialised form of AI (Summerfield, 2025), which are based on principles of neurocomputation, has attracted interest and concern in equal measure. Despite this concern, an analysis of world leading universities in several countries found less than half had published guidelines for academics on their use (Moorhouse, et al., 2023). Training in their appropriate use is likely to be part of the future skills set of doctoral students.

It is clear that AI tool use in doctoral education will increase, as students become more aware of the potential benefits they offer to their discipline, whether STEM or non-STEM based (Blease et al., 2021; Khanagar et al., 2021; Meron & Araci, 2023; Parviz, 2024; Yilmaz et al., 2023; Yüzbaşıoğlu, 2021). Questionnaire and interview studies with postgraduate students drawn from a wide range of countries – including China (Xu et al., 2024), Ghana (Segbenya et al., 2023), Hungary (Tick et al., 2023), India (Mohammed, et al., 2023), Indonesia (Mulimin, 2023), Morocco (Bouzar, et al., 2024a), Portugal (Costa, et al., 2024), and South Africa (Chauke et al., 2024) have found that ChatGPT is judged to be beneficial for research planning, information searching, proofreading, and academic writing. Work also points to its deployment in research supervision for the provision of personalised feedback (Dai et al., 2024) as well as detection of suicide risk (Ophir et al., 2020). Demographic differences have also been observed. Current data suggest ChatGPT is more favoured among high income groups (Baek et al., 2024), with gender differences observed in the way AI is used, ethical concerns held toward its use (Møgelvang, et al., 2024) and the frequency and amount of time it is employed (Bouzar, et al., 2024b; Nyaaba et al., 2024).

3.2.2 Problems Associated with Artificial Intelligence

As well as the benefits of AI use, several concerns have been documented. There is evidence that ChatGPT use is associated with delayed task initiation, thereby affecting students' customary time management practices (Bouzar, et al., 2024c). On this front, academic workload and time pressure have been found to precipitate students' ChatGPT use (Abbas et al., 2024). Unease has also been expressed about the potential for dependency, addiction and reduced creativity in AI users (Das & Madhusudan, 2024) as well as the ensuing problems of plagiarism and plagiarism detection which may arise from its use (Bhullar et al., 2024; Hutson, 2024; Landers, 2024; Rasul et al., 2023). Furthermore, the reliability and accuracy of ChatGPT generated output (Vaishya et al., 2024; Xu et al., 2024, Schei et al., 2024) has been repeatedly questioned.

There are indications that the above concerns are shared by students (Shoufan, 2023). Given the unsatisfactory ability of current assessment tools for detecting plagiarism (Chaudhry et al., 2023) – and there has been a steady growth in the availability of such tools (Wang et al., 2024) - data showing a high positive correlation between ChatGPT use and academic performance (e.g., Khan, et al., 2024), while inconclusive, do little to alleviate concerns that the tools will be used inappropriately. This is evident in work by Deng at al. (2025), who conducted the first systematic review and meta-analysis of experimental studies (N=69), across diverse learner populations, into the effect of ChatGPT on student learning. They reported ChatGPT use was consistently associated with increased academic performance, motivation and higher order thinking but also reduced mental effort, although these effects varied across subject areas. The authors cautioned that the observed improvements in academic performance may simply have arisen as the direct result of ChatGPT's role in producing higher quality work, as many of the studies included failed to exclude its use during assessment of students' academic performance. Similarly, no objective tests of higher-order thinking were used. It is of note that the only study included in the analysis which assessed the effects of ChatGPT use on originality (Niloy et al., 2023) found a detrimental effect.

It is evident AI use offers great potential to enhance and support doctoral education, but the promises offered come with considerable challenges, the possibility of new causes of stress, new ethical problems (UNESCO, 2021) and potential for disruption (JISC, 2024). Because of this, AI use will require careful management to ensure its appropriate "development while preserving trust in research and research integrity" (Moody, 2023). Holmes and Tuomi (2022), who developed a taxonomy of AI applications in education, have spoken of its potential to streamline supervisor's administrative burden, but have also stressed the need for AI literacy, which will require reflection on the appropriateness of AI generated output, as well as the technical proficiency to use the tools well.

3.3 Role of Technology for Postgraduate Students

The precise applications of technology required in a study programme necessarily varies, but one can envisage a repertoire of essential digital talents that will incorporate general skills in word processing, editing and formatting, data entry, file management, graphic presentation, spreadsheet manipulation, use of network communication systems and some degree of data analysis (Wallace & Clariana, 2005; Blignaut & Els, 2010; Meerah, 2010). To these can be added, use of videoconferencing, AI and social media.

Prior to the advent of AI, there was a widely held view that postgraduate students (particularly in the early stages of a PhD) do not require training in computer education, it being presumed they already possess relevant computing experience from their undergraduate or Masters' education (Dange, 2010). Consequently, doctoral students' existing capacity to utilise technology in research work was largely accepted as sufficient.

The assumption of doctoral students' knowledge however has always been questionable. Several studies report a proportion of graduates studying for a higher degree struggle to cope with the demands of ICT (Nair & Pillay, 2004; Henderson et al., 2015). There is also evidence that university students are not necessarily skilled at handling operational software, such as PowerPoint and Excel or the learning management systems used by a university (Dange, 2010); consequently, more recent tools for communication and AI, can be expected to pose problems for some. In addition, familiarity with given software cannot be assumed to translate into proficiency in using it (Horowitz et al., 2024). There may be several reasons for this - insufficient computer literacy, low confidence in learning new systems, overconfidence in using what one is familiar with, as well as fear of advanced technology (Castles, 2004; Juutinen et al., 2011; Horowitz et al., 2024), all of which can inhibit the need to explore and experiment with software – important ingredients in maximising its potential.

Some researchers have suggested that digitised research materials make the research process easier, allowing researchers with less knowledge to access materials more rapidly than was previously the case (Peters & Gross, 2021). The view that age may be a barrier has also been considered – that older researchers, previously accustomed to working with non-digital source materials, may judge their digital ability to be lower than younger colleagues'. However, a study of postgraduate engineering students, Gross et al. (2017) found no difference in self-efficacy ratings of older ("digital immigrants") and younger ("digital natives") students - a finding echoed by Creighton (2018) who concluded there was little relation between age and digital skills and increased learning, with much of the research in fact suggesting that the competence of "digital professors" may well exceed that of their students. A more relevant distinction may well be the level of confidence and/or experience which both students and staff bring to their respective roles in higher education and their relationship with one another.

In the year before the onset of the pandemic, Ankamah, et al. (2018) argued that the use of ICT in research had transformed research - through improved analytic techniques, allowing manipulation of large datasets, having easier access to other's research, and the possibility of rapid feedback. They also suggested social networks and web portals have reduced barriers to research cooperation across geographical distance (Al-Haririr & Al-Hattami, 2017). This question of how communication between colleagues and peers is affected by technology and how the nature and quality of it has changed since the pandemic is important. With the lack of research on the influence of technology on PhD students, the current study addresses the role of technology in communication with colleagues and peers.

It is stressed that pre-COVID-19, research findings were undertaken when online teaching was optional, and technology development had yet to reach present day capabilities. A comparison between pre-and post-pandemic delivery therefore would likely yield significant differences in content, method of presentation and purpose. Although this work shows that teacher and class perceptions may be positive, future studies focusing on students' and teachers' experiences of online teaching and education will need to consider wider aspects of people's lives both during and after the pandemic, and to ascertain the extent to which students perceive technology has helped them to overcome difficulties experienced during it.

In interviews with faculty staff, Griffith et al. (2021) explored their engagement with doctoral students in online courses. Five important themes emerged from the research: active learning and application of material, formative feedback, community building and instructor presence, student collaboration, and use of technology. In particular, Zoom was found to be an important technology for synchronous communication. Other internally provided university technologies were also used by some researchers. Others used external recording tools, to provide videos for the students and made use of Twitter to encourage student discussion. Concern was expressed however that students could be overwhelmed by too broad a range of technologies.

3.3.1 Attitudes to Technology Use

While technology has advanced considerably in recent years, there is little reason to imagine fear of technology has decreased. In fact, as technological systems grow more complex and less intuitive, it may have increased. Al-Maroof et al.'s (2020) study of 450 students suggests this fear, so-called 'technophobia' remains a relevant issue – and may be affected by the perceived usefulness of the new technology together with its perceived ease of use and the perceived norms surrounding its use. Al-Maroof et al.'s work implies, as is often the case, that past behaviour may be a potent guide to future behaviour, with previous adverse technological experiences presenting an obstacle to future learning. Given this, expectations that learners bring to the social and technological environment in which they will be studying may be critical (Harerimana & Mtshali, 2019). Course directors and supervisors may therefore wish to consider assessing the attitudes toward technology of new intakes of students, allowing potential problems to be addressed early on (Olsen, 2020). Referring to 'attitudes' in this review, does not mean they are treated as fixed or purely individual dispositions. Instead, attitudes toward technology can be understood as socially and institutionally mediated interpretations, shaped by academic socialisation, available support structures, and the normative expectations of doctoral students.

While technology offers doctoral students flexibility in studying, access to global information resources, research networks, and opportunities to generate new professional knowledge, there have been relatively few studies examining student attitudes to technology use. Those that have (e.g., Keller & Cernerud, 2002; Buzzetto-More, 2008; Ituma, 2011; Yilmaz et al., 2023; Katsantonis & Katsantonis, 2024), report positive viewpoints toward online education and technologies. These positive views, however, may be dependent on the support offered to students. For example, Schafer's (2012) case study of an institution-wide switch to online education found the switch's effectiveness was contingent on the quality of institutional support provided. This included training teachers and faculty to interact with students and establish a clear community experience, particularly for those considered academically disadvantaged. Several studies point to gender differences in the cognitive and affective components of attitudes (Svenningsson et al., 2022) and in the use of mobile technologies in education (Mâță et al., 2021), though the potential significance of these in relation to emerging AI technologies and the relationship between attitudes and prior experience is not clear.

In work prior to the pandemic, Cummings (2019) examined students' experiences and perceptions of technology use in distance learning, in order to identify factors which could improve the student experience. The most beneficial aspects of distance learning were judged to be interactive engagement among academics and students, as well as interactive content and practice, with timely, good-quality feedback. Student perceptions in other domains of technology use have also been investigated. Alotaibi and Johnson (2020) for example explored the perceptions of international postgraduate students towards the use of Google Scholar. Having considered a range of organisational, individual, and social factors within the postgraduate setting, they concluded that students were able to function as independent researchers, utilising what they considered the most effective tools for locating literature for their studies. Social context, it transpired, had no strong effect on students' intentions to use a particular search tool.

The recent JISC (2024) digital experience survey points to a high percentage of respondents accessing online learning activities (84% accessed course material online, 77% watched lectures, 66% participated in live online lectures) and high student satisfaction with online learning environments –85% judging them to be "above average." However, this finding must be interpreted with care, as the respondents do not know what the actual "average" across the sector is. On any metric 50% of scores will be above the mean and 50% below, hence at best the questionnaire item can be considered poorly worded. In addition, the survey is far from representative of the UK student population (60% female, 30% Asian/Asian British) and may be biased toward those more positively predisposed to technology. The possibility of bias in the survey is illustrated by the fact that a higher percentage (44%) agreed they were comfortable with how their university collected and used their data, than the percentage (40%) agreeing that they understood how their university collected and used their data. Unfortunately, no findings are broken down by level of study to enable any snapshot of the postgraduate population (33% of the respondents were postgraduate) to be inferred and whether their views differed from respondents at other levels of study.

Davis (1989) made the point that technology is more likely to be used by an individual if it is perceived as useful and easy to use. However, the role of perception may be more influential in personal than in institutional settings such as doctoral courses, where policy decisions on technology use are made centrally. Furthermore, an individual's perception may be influenced by others (e.g., friends, fellow students, or teaching staff) who may then influence the individual's choice of technology and the purposes for which it is employed (Ang et al., 2015; Shan & King, 2015). These purposes may include using social media to remain attuned with current literature (Bonetta, 2009; Gu & Widén-Wulff, 2010; Stephens & White, 2024), to disseminate research-related data, and to endorse research projects, publications, and conferences (Letierce et al., 2010a; Priem & Costello, 2010; Terras, 2012; Le Busque & Mingoia, 2023).

While evidence indicates most postgraduates perceive ICT to be vital in research, Ankamah et al. (2018) argued that the adoption of advanced ICT at universities can be affected both by students' perceptions and by academic staff's attitudes towards it. It has also been suggested that there is insufficient evidence regarding how students perceive the effect of technology on wellbeing and learning (Wang et al., 2018), which is known to have multiple determinants beyond the technological realm. Again, this is an issue the current research will address.

With doctoral education becoming increasingly digital, supervision and institutional settings underlying these practices become increasingly important. The next section elaborates on this, reviewing the institutional context within doctoral students' experience of technology is situated.

3.3.2 Institutional Context of Technology Use

It has been suggested that the digitalisation of learning materials at universities has largely been prompted by institutional and governmental policy (Tomte et al., 2019). Internal development, sparked by academic and student interest alone, has rarely been the case. If anything, the pandemic has shifted the balance from a personal choice to engage with digital media to an institutional policy decision that the shift online is necessary for the higher education system to continue functioning effectively. The lesson from Davies (2021), is that if the digital transformation of learning is to be a viable long-term model for education, more freedom must be given for course development to be generated from the free-flowing interactions of staff and students. Successful development necessarily depends on a supportive and functioning technical infrastructure, the availability of appropriate tools for accessing literature, data collection and analysis, communication and networking, as well as widespread knowledge of their use within a given discipline. Furthermore, the attitudes and motivations of staff and students, good-quality relations between staff and students, and a willingness to invent new tools as the need arises are also important.

The ability of videoconferencing software to contribute positively to the academic social environment has been supported by Rockinson-Szapkiw et al.'s (2014) study of doctoral students' use of both university and non-university technology in their Doctor of Education programme. They found that students who communicated with others via Skype, Twitter and Facebook rated their connectedness with peers higher than those who communicated either by email or by telephone. It has also been suggested that use of videoconferencing in online courses has contributed to increased student engagement and improved outcomes (Massner, 2021). However, reports of videoconferencing fatigue and distraction are growing (Cranford, 2020; Fosslien & Duffy, 2020; Wiederhold, 2020; Bailenson, 2021; Lee, et al., 2022; JISC, 2024). Any longer-term effects of increased technologically mediated communication and interaction 'on campus' are, however, harder to predict and potential effects on student engagement, identity formation and feelings of belonging to the academic community remain largely unknown. All these issues may assume different degrees of importance for students (and staff) of different disciplines.

3.3.3 Technological Factors

While software has arguably played a huge role in the digital transformation of higher education, the hardware used by students should not be overlooked. An online survey by Al-Hariri and Al-Hattami (2017) found that undergraduates' use of technology had a major impact on their academic achievements. Laptops (used by 50% of students), phones (42%), tablets (7%) and desktop computers (0.5%) were the most frequently used devices. While Boud and Lee (2005) suggested doctoral students use technological tools and networks to advance their studies; it remains unclear exactly how technology is employed in the process of writing up work.

3.3.4 Online Education

Online education constitutes a different form of engagement than face-to-face (Lemay et al., 2023). There is extensive research on this regarding learning outcomes (Martin et al., 2020; Idrizi et al., 2021), with evidence suggesting online learning can be successful in students' own terms (Fernandez, 2011; Kim et al., 2023). One factor in evaluating the relative merits of each concerns the effects on teaching methods (Prosser & Trigwell, 1997; Trigwell & Prosser, 2004). González (2012) detected seven principal themes for how e-learning affects teaching methods; through an institutional approach; teacher control; educational and technological support; time needed; teacher expertise; student competence; and preparedness to employ technology. To this list, Li et al. (2025) have added how well learning objectives are articulated as well as opportunities for non-content-related social interaction.

A review of the relationship between technology and student online learning in higher education conducted several years before the pandemic, noted that students had positive experiences of it, though there was mixed evidence for its efficacy compared to conventional education (Nora & Snyder, 2008). In a subsequent case study, Journell (2010) found that the instructor and most of his students experienced online education as little more than information conveyance. Meanwhile, Al-Hariri and Al-Hattami (2017) found differences between the approaches taken by instructors who used technology in their teaching and those who did not, with non-technology users tending to favour a more structured approach, with an expressed preference for content provision over practice. In contrast, instructors favouring a high level of technology use were more oriented toward their students developing critical thinking and a desire to learn. They concluded that technology enables many important learning processes, including self-directed, independent, collaborative, and practical learning. The authors called for future work to examine students' use and perceptions of technology and the ways in which this facilitates learning and study progress. The current research will be one response to this call.

More recently, Lemay et al. (2023) noted teachers' appreciation of the comparative advantages of online learning, with Smidt et al. (2017) demonstrating positive effects, particularly concerning availability of teaching in low socio-economic and developing countries. The institutional context of the present research, conducted in a prestigious university in an affluent country, provides a different context. Whether similar issues arise across both developed and developing countries remains an open question.

In short, there have been few investigations of graduate students' attitudes and perceptions towards technology, with some of these occurring pre-pandemic. The current study directly addresses this gap. Understanding the technology experience of PhD scholars and its connection with technology adoption (Vallade et al., 2020) in an ongoing study programme is vital. In addition to perceived usefulness and ease of use, the original technology adoption model has been extended to include task variability, system complexity and accessibility, self-efficacy, emotional reactions, and social factors such as peer influence and social norms (Granić, 2022).

The following section will consider a specific area of technology use which was not originally designed with educational aims at the forefront, but which has subsequently been appropriated for educational purposes and utilised by doctoral students.

3.4 Social Media in Education

In the context of higher education, social media sites that facilitate user-generated content, networking, and interaction include Facebook, Twitter/X, ResearchGate, LinkedIn, and YouTube. These enable doctoral students to host professional profiles, access the work of others, share their own work, and network/engage in discussion with other academics (Ebner et al., 2010; Thanuskodi, 2011; Powell et al., 2011; Weller, 2011; Veletsianos & Kimmons, 2012; Zhu & Procter, 2015; Arcila-Calderón, et al., 2019; Le Busque, & Mingoia, 2023). This work suggests potential criteria that participants may employ in assessing the advantages of technology use. The 'Diffusion of Innovation' theory (Rogers, 2010) suggests that when deciding on whether to adopt or reject an innovation, its advantages and disadvantages must first be assessed. This issue lies at the heart of the current research.

In exploring PhD candidates' use of Twitter, Facebook and research blogs in academic communication, Zhu and Procter (2015) conducted interviews and case studies of chat conversations. They observed how these social media platforms were utilised to endorse professional profiles, receive peer support and feedback as well as disseminate research to a wider audience. As PhD candidates usually lack peer-reviewed publications, blogging can be an effective way for PhD students to raise their academic profiles get their work into the public domain (Fawns, et al., 2021). In general, blogging functions as an informal 'publishing platform' offering a record of a person's research, and a means of disseminating research ideas. It is utilised in academic journals such as 'Science' and 'Nature' (Kjellberg, 2010). Reputed academic publishers such as the Public Library of Science (PLoS) and the Nature Publishing Group (NPG) have endorsed blogging to promote academic papers (Stewart et al., 2013).

Blogging may also function as an aid for improving research writing, which may lead to formal publishing opportunities later. Alternatively, it has been suggested that the time and dedication devoted to blogging and establishing networks on social media, even though young academics have more time to engage in blogging than tenured faculty (Nicholas & Rowlands, 2011; Crotty, 2011), can potentially reduce time available for research activities (Coverdale, 2011). In the UK, a serious impediment to blogging as publishing is that the Research Excellence Framework (REF) does not currently recognise academic outputs on social media. In many institutions, though not all, careers still largely depend on formal, peer-reviewed publications.

Several authors contend that social media use and online learning have potential to transform how writing groups function in students' lives (Guerin et al., 2020; Liu et al., 2021), to increase student motivation (Ramzan et al., 2023) and boost academic attainment (Wilson & Anam, 2024) and mental health (Le Busque, & Mingoia, 2023). Nevertheless, social media must be used with care. For example, while students benefit from technologically mediated peer feedback –reducing shyness and overcoming obstacles to giving feedback – concerns have been voiced that feedback delivered online lacks the richness of detailed social feedback which face-to-face interactions permit; with these understood to be positive, supportive, thorough, and pleasant (Liu et al., 2020). Concerns have also been raised about the potential disadvantages of peer feedback in terms of inaccuracies and absence of academic rigour (Yu, 2021). Zhu and Procter (2015) discuss the need for researchers to be aware that social media platforms can act as a conduit for leakage of ideas to other researchers, prior to publication. They believe that social media must not be seen as an alternative to peer reviewed publications, though it may still act as an outlet and support vehicle for research.

In sum, social media has potential in doctoral education: for identity development and promotion, networking and collaboration, disseminating research, and informal peer teaching. However, there are significant challenges and risks relating to overload, distraction, scholarly integrity, and confidentiality. As such it provides opportunities and challenges which complement the more formal technology spaces in institutional settings.

3.5 Stages of Doctoral Programmes

As technological use is likely to vary with the stage of a students' studies, several commentators have proposed viewing student's digital needs through this developmental perspective. Authors have proposed students' changing digital needs can be considered either in terms of academic socialisation or in terms of an unfolding sequence of academic tasks – induction, orientation and familiarisation with literature, methodology, design, data collection, analysis and writing up (Gardner, 2009; Grover, 2007; Gardner, 2008; Terrell et al., 2009; and Wao & Onwuegbuzie, 2011).

First, it must first be acknowledged, that this trajectory is somewhat idealised and that during the pandemic, for example, existing sequencing of practical work and supervision, at least in some disciplines were seriously disrupted (Brown et al., 2024). Secondly, it might be expected that distinct groups of doctoral students will experience these stages in different ways. For example, part-time, distance learning and international students may have different needs with varying degrees of reliance on communication (Wisker, 2023). Thirdly, there is considerable interdependence between the trajectories of socialisation and academic tasks. For example, the first stage in a programme has been envisaged as comprising the first two years with initial supervisor and peer interactions (Rockinson-Szapkiw & Spalding, 2014), while the second stage may be more localised and depend upon developing consistent communities of staff and students (Rockinson-Szapkiw et al., 2019). These distinct social patterns will be concerned with the students' different academic needs at each point in the doctoral journey. One such example may be that students who have been studying longer may be more likely to contend with digital fatigue or future carer concerns. This type of social support may be more difficult to deliver in online programmes, as later periods of study are spent writing up, a time characterised by less social interaction with peers and colleagues.

The final stage of study is one of relative isolation, where there is a risk of dropout (Terrell et al., 2009). During this stage the importance of communities involved in the dissertation process and career preparation are of great importance (Peters et al., 2015; Ciampa & Wolfe, 2023). Rockinson-Szapkiw et al. (2016) called for staff of distance education programmes to be ready to enable technology-based communication and to provide timely responses to students throughout the doctoral programme. Throughout doctoral study, a combination of supervisory guidance, institutional support, and technological competence and/or training can be considered as necessary.

3.6 Online Doctoral Programmes: A Growing Trend

Online doctoral degrees are characterised as systematic research training degree programmes in which study, supervision, and academic engagement are offered or delivered primarily online rather than through campus attendance (Singh & Thurman, 2023). Following the pandemic the trend toward greater online delivery can be expected to increase, alongside the increasing globalisation of higher education, with resultant competition for students also considered a factor (Taylor, 2023). Studebaker and Curtis (2021) noted how in 2018, almost 900,000 students in the US were registered in a full-time online graduate programme, with a further 270,000 registered on some form of online course. Prior to the pandemic, it was observed that almost 40% of all US graduate students were enrolled in online courses

(Muljana & Luo, 2019; NCES, 2020c), an indication of the flexibility, availability, convenience, and individualised learning opportunities they potentially afford (Studebaker & Curtis, 2021). These online programmes allow greater access for overseas, part-time and mature students and permit candidates to pursue their careers and maintain family and community ties alongside their studies (Terrell et al., 2012; Bawa, 2016; Muljana & Luo, 2019; NCES, 2020c). This ability to balance home life with studying therefore enables virtual platforms to sustain a more diverse student population (Studebaker & Curtis, 2021). It is possible, however, that any mandatory move to online course delivery for a mainstream student audience may not be completely welcomed.

Although advantages of online doctoral programmes are clear, they come with distinct challenges (Wisker et al., 2021). The traditional nature of the academic community has relied on face-to-face contact. An online programme in contrast must provide virtual mentoring and supervision which are largely experimental, with potential knock-on effects on programme attrition, with sense of community, informal peer support, and formation of academic identity– the psychosocial architecture of postgraduate work - all affected (Studebaker & Curtis, 2021; Lively et al., 2021). There are also increased cognitive demands on students and increased effort required by staff to deliver the programmes – with these factors potential mediators of a programme's success (Welmer et al., 2025).

A core component of academic work and identity is concerned with writing. This is notably true for doctoral candidates (Aitchison & Guerin, 2014). The necessity to develop one's writing ability is recognised as posing emotional, social, and cognitive challenges, which may concern self-efficacy, social interaction with others, and demonstration of a sufficient knowledge base (Ahern & Manathunga, 2004). In recent years, practice-based writing groups have provided a means of supporting doctoral candidates (Maher et al., 2013; Lie et al., 2021), with evidence that these improve confidence, writing skills and knowledge, as well as engagement with the academic community (Maher et al., 2013; Kumar & Atkinson, 2018). While technology may play its part, it is important to remember that it is but a means to the end of student learning and remains secondary to the relational and motivational component of the learning environment (Lee et al., 2020; Rahmani et al., 2024). In this context – it is striking that a review of technologies used in online doctoral education emphasised the role of both asynchronous and synchronous communication in building a sense of community (Lee et al., 2024).

3.7 Cultural Differences in Use of Technology

Cultural differences in technology refer to how social, national, and institutional practices shape the use of technological tools, and how these practices are understood and interpreted by doctoral students. How digital technologies are implemented by students can be shaped by pre-existing experiences, values, expectations and competence, all of which are likely to be culturally situated.

Boulton (2019) contributed to the debate on technology use, by considering the plight of transnational doctoral candidates. She focused on a professional doctorate course produced by a UK-based university and taught in Hong Kong (HK), by UK academic staff over four weekends each year, with supervisory support from UK based tutors. Data was collected using software analytics, questionnaires and focus groups to understand candidates' learning experiences. The course was initially delivered using the identical VLE (for course materials, email, discussion boards etc.) as those studying the course in the UK. However, Boulton (2019) suggests that Asian students typically differ from Western students in their learning methods, pedagogical experiences, and ways of interacting with tutors. She maintains that their different cultural learning experiences can affect motivation and how they interact with learning technologies. Some of the differences in expectation may concern models of supervisory practice – for example whether these are hierarchical or collaborative (Kandiko Howson et al., 2022; Almlöv & Grubbström, 2024).

Boulton's work highlights how technology must be carefully applied in education to avoid disadvantaging specific groups (e.g., particular cultures or nationalities). This point needs consideration, given the numbers of international and transnational students studying at UK universities, including the university in which the current study is situated (Higher Education Statistics Agency, 2023). Boulton's (2019) internationalist, cross-cultural approach is intended to furnish a community of practice across continents, one she believes will promote critical thinking, collaborative learning, co-construction and cross-fertilisation of ideas. These goals should inform and influence how technology is used, so that technological platforms are selected to meet specific pedagogical aims rather than the technology simply shaping what forms of pedagogy are possible.

While Boulton (2019) focused on postgraduates, her approach could potentially shed light on the challenge of technology use with transnational students, in general, and those in Southeast Asia, in particular. She notes that despite ample literature on technology use in teaching and learning in the West, research into transnational postgraduate students' use of technology, learning experiences and perceptions remains limited (McConnell et al., 2008; Arenas, 2009; Choudaha & de Wit, 2014; Boulton, 2019). In collectivist versus individualistic cultures there may be different practical and emotional values placed on face-to-face peer learning and technologically mediated independent work, for example (Gherhes et al., 2021; Bright & Vogler, 2024; Rasheed et al., 2024). With the advent of AI opening-up possibilities for customised educational support delivered in a local 'variant' (Wang et al., 2023) these cultural differences may be accentuated. Although the current study considered the technology use of all participating doctoral students, the investigation was open to the possibility of shedding light upon differences between international and UK students.

3.8 The Influence of Technology on Productivity through the Study Process

Productivity in doctoral research can encompass research publications, books/book chapters, conference presentations, acquisition of skills and successful networking. In sum, productivity refers to both the efficiency and quality of the research and the intellectual and social processes which support it. Several issues govern how productive students are in their technology use. These will be considered alongside the different stages in the research process.

In the early stages of research preparation, and throughout the period of study, an important issue is access to needed resources. For students in developing countries quality of the network infrastructure is of great importance. As remote study becomes increasingly favoured by universities, and students choose to remain in their home countries and study remotely, the quality of network infrastructure in other countries is likely to grow in importance. Expanding network facilities therefore may be a priority amongst the infrastructure projects that universities invest in as they seek to broaden and deepen international ties and collaborations. As an illustration of this issue, Edem and Egbe (2016) reported utilisation of e-resources by postgraduates (in Nigeria) was frequently hampered by slow network operation, inconsistent internet connectivity and power outages. What this means is that in line with the international drive to build a professional workforce able to meet the financial obligations of both universities and the wider society, it is vital that the availability and functionality of technology is considered (Brooks & Pomerantz, 2017).

Care must also be taken in the design of the digital environment, not least because these exist subject to continual upgrades, sometimes entailing a loss of functionality for users. According to Dange (2010), this constant development must be accompanied by ongoing research into how the network experiences of users are affected, including their understanding of the digital environment and how their productivity is improved or impaired.

The technological infrastructure aside, there is evidence that many postgraduates' proficiency in general skills dealing with word processing, spreadsheet, database applications and presentation software (Dange, 2010; Ankrah & Atuase, 2018) is poor, although research indicates graduates appraise their own general computing skills positively, with high levels of confidence in their ICT skills (Khurram, 2020). These skills, however, are primarily self-taught. Perhaps because of this, many participants have limited awareness of the breadth of computing skills needed in their doctoral study environment. There has been a presumption, shared by students that their technology use is largely oriented toward acquisition of information (Griffiths & Brophy, 2005; Sutton & Jacoby, 2008). Survey work concurs with this. Approximately 75% of respondents questioned on the use of technology in their education stated the most significant advantage provided was in referencing and locating scholarly sources (Economist Intelligence Unit, 2008).

Investigations on graduate scholars' productivity, which has examined how they use data online or practice their work are limited. What work has been done points to the importance of supervision. It has been suggested, for example, that the supervisor's research experience is associated with greater research output by the doctoral candidate (Laupland et al., 2021), while in a quasi-experimental study, Ng et al. (2020) found supervised learning in using specific technological devices aided academic performance.

Evidence indicates that electronic resources are important when it comes to doctoral students drafting their dissertation (Aderibigbe & Aramide, 2006; Dange, 2010; Dahlstrom et al., 2011). Google Scholar remains a popular resource amongst web-based databases (Ankrah & Atuase, 2018). One consequence of increased digitisation of knowledge is that the size of reference lists in doctoral dissertations and journal articles has steadily increased (Mammola et al., 2021), another is that academic fields have become more inter-connected with an increasing capacity for scholars in different fields to communicate with one another. With this comes an expectation for doctoral students to engage with a more diverse field of literature than perhaps was the case for earlier generations of scholars.

However, it appears that students use computers as logistical tools for obtaining and interpreting web-based information rather than creatively participating, either alone or collaboratively with others, in the active production of new knowledge. The introduction of AI has the potential to change this, for better or worse. In this regard, Holford (2019) has expressed reservations on the potentially detrimental effect of algorithmic 'logic' – what he terms 'machine efficiency' on the human capacity for genuine creative thought. This is an issue which has the potential to change doctoral productivity in both kind and degree – with students of different disciplines employing technology in quite different ways (Henderson et al., 2016).

It must be stressed that how students utilise technology is not limited to software. Thus, there is a need to investigate how they combine, practise, and apply different technologies, beyond those concerned with communication, journal and web browsing, data acquisition and analysis. Many investigations of postgraduate students' technology utilisation depend upon data collected through interviews, questionnaires, and surveys – i.e., with no direct observation - without considering the validity of the data. In conducting any research in this area, as we have already seen, caution must be exercised in uncritically interpreting self-report measures of functional skills – such as ICT competence (Conole et al., 2008). In the current study, where triangulation of methods and analysis will be utilised, there is an opportunity to enhance data validity and its interpretation.

One may surmise from above that technology has much to add to the research efforts of doctoral students –administratively, analytically and productively. Set against this are the possibilities for distraction, overload, fatigue, over-reliance on technology, over-extension in social networks and under appreciation of the importance of non-technologically augmented creativity, all of which can negatively affect performance (Lee, et al., 2022; Hilty et al., 2022; JISC, 2024). In the next section how the benefits and problems overlap with supervision and institutional infrastructure are further considered.

3.9 Importance of Synchronous and Asynchronous Communication

Synchronous communication refers to conversations, communication exchanges which are conducted in real time, for instance via video conferencing or live chat. This may be between supervisor and student, between peers or virtual conferences. Asynchronous communication refers to exchanges which occur with delay –including for example email, discussion forums, and recorded lectures - which allow for greater convenience and less urgency in responding. These represent an earlier phase of digital evolution, and though synchronous communication represents a distinct leap forward, asynchronous forms remain of value. Both synchronous and asynchronous communication have specific strengths. Asynchronous communication for example may be optimal for reflection, record keeping, feedback on work and knowledge acquisition (Mansours, 2024). Each form can be regarded as complementary to the other, with advantages from one offsetting the disadvantages of the other in specific contexts.

Research suggests that synchronous communication is important in online courses, conferencing and supervision, where real-time intellectual, emotional, and motivational feedback is important (Polkinghorne et al., 2023). The immediacy of communication through videoconferencing can encourage faculty-student engagement and through that reduce isolation, promote integration and aid retention in online courses (Maul et al., 2018; Rockinson-Szapkiw, et al., 2019). Numerous online doctoral candidates experience difficulties in engaging with supervisors and peers, with potential consequences on well-being and performance. Synchronous communication enables participants to take part in the comfort of their own homes which can help reduce anxiety (Garrison & Arbaugh, 2007; Terrell et al., 2009; Li et al., 2025). In a similar manner videoconferencing opens the door to interviewing participants for whom travel and face-to-face contact poses difficulties (Irani, 2019).

The benefits of engagement with supervisors, faculty, and peers are well recognised (Maor & Currie, 2017; Motte, 2020; Lee et al., 2024). This contributes to building empathy, trust and rapport. What remains unclear is how the balance between synchronous and asynchronous delivery can be optimised to aid the motivation, learning and satisfaction of individual students whose needs with respect to immediacy and sensory stimulation will differ – as with neurodivergent students (Walther et al., 2025). What has been observed is that online doctoral students who experience a balance of both synchronous and asynchronous communication display better integration with peers and faculty, and greater persistence in their work (Teng et al., 2012; Fuller et al., 2014).

Once again, the reliance on online delivery of educational content during the pandemic is noted. For some this led to disruptions in data collection, greater need for emotional support and the necessity to adapt research plans (Krumsvik et al., 2024). This will be discussed further below.

3.10 Effects of the COVID-19 Pandemic on Technology in Education

Educational practices were transformed in response to restrictions imposed in the wake of the pandemic (Kessler et al., 2020; Lemay & Doleck, 2020; Watermeyer, 2021) and which led many universities to switch to an online education model (UNESCO, 2020). It is evident that PhD programmes were significantly affected with abrupt switches to online research, supervision, and study spaces (Krumsvik et al., 2024; Hassan, 2025). This change in teaching delivery can be expected to affect participants in the present study. Further investigation is required to understand the impact of this online approach on both students and staff.

3.10.1 Disruption

The closing of educational institutes during COVID-19 was primarily undertaken to protect students. Almost three-quarters (73.8%) of all students globally were affected, with around one in five, absent from education as of March 2020, across 75 countries (Muthuprasad et al., 2021). In the US, 84% of higher education students had at least some of classes moved online (Moore & Hodges, 2023). Students in science disciplines which necessitate on-site work in laboratories faced greater challenges which were not as easily addressed by remote pedagogy (Fox et al., 2020; Kelley, 2021). The record of how these challenges were faced remains a vital resource for future contingencies. Watermeyer (2021) reported abrupt changes in the nature of staff workloads, with some referring to a greater emphasis on pastoral support; others regarded the ‘digital turn’ as corrosive to core academic values.

3.10.2 Adaptation

During this period, students and educational institutes employed technology in inventive ways to enable students to complete their studies, although some institutions were closed indefinitely. Most universities moved teaching to online platforms such as Microsoft Teams, Zoom and Blackboard as institutes in affected locations looked for temporary measures to maintain teaching delivery (Muthuprasad et al., 2021). In a novel approach to the adoption of videoconferencing, Maroof et al. (2020) considered students' and staff's perceived fears in relation to perceived ease of use and actual use. With virtual learning environments differing substantially from traditional classrooms and facilitating different emotional dynamics, the authors argued that group dynamics of the virtual classroom must be considered alongside individual psychology, as this may affect students' satisfaction, engagement, and motivation (Bignoux & Sund, 2018).

An illustrative example of flexible pedagogy in the face of the pandemic is provided by Davies' (2021) case study of a quantitative research methods module, taught in lectures, workshops and self-study, supported by online resources. As this initial format appeared problematic, the module was reorganised into a series of seven one hour-long, synchronous online seminars, provided fortnightly to a small group, with those residing near campus invited to attend in person. Prior to seminars, participants were directed to read specific texts and watch particular videos designed to provide baseline understanding. The new structure enabled learning to be more problem-based and discursive (Jones & Palmer, 2020), allowing students to engage in practiced learning conversations with one another. Davies described how each videoconferencing seminar, was delivered via an onscreen presentation – 'showing' rather than 'telling' - with candidates taken through topics in a stepwise manner at a suitable pace. She noted how candidates were encouraged to actively participate in workshops by reproducing statistical tests on their own devices and taking presentation rights. This provided a means for individual users to obtain hands-on experience with the software. In addition, the forum encouraged a sense of community. With a small number of students, frequent meetings were possible and common experiences of confronting statistical problems shared. Davies attributed this community development to an online variant of the 'cohort effect' observed in other programmes.

This is an instructive example, prompted by COVID-19, of how technology can be used creatively to support an imaginative, socially structured, small-scale learning environment. Whether this can be 'scaled up' to larger groups of students in an increasingly global marketplace where education is mass-produced remains an open question.

3.10.3 Legacy

One legacy of the pandemic is that videoconferencing tools, VLEs and learning management systems have increased in popularity and are now a visible component amongst the available resources used by students and staff. These resources are expected to shape future communication in important ways. One problem however, in assessing effectiveness of online learning is that VLEs and developments in video conferencing technology have led universities to presume that interacting with students remotely is always a convenient and inexpensive alternative to face-to-face interaction. Whilst this may offer economic rewards for institutions, whether it is optimal pedagogically or psychologically for students is another matter (Sa¨ljo, 2003; Wikeley & Muschamp, 2004; Russo, 2025). An inherent danger with prescriptive technological 'solutions' to pandemic created problems is that doctoral candidates may be discouraged from following their own direction of study and by missing out on face-to-face interaction may become less effective. A study of students who had transitioned from face-to-face to remote learning during the pandemic found many felt it had negatively affected their learning (Serhan, 2020). Russo's (2025) recent work on the influence of technology on student satisfaction during the pandemic pointed to the importance of relationship engagement, as well as the expectations fostered by an institution. This work suggests data from the present study will have particular importance.

There is evidence to suggest that academic staff are content with using new technology. Lemay et al. (2023) also found that two-thirds of teachers reported being happy with using new technology, with only 13% dissenting. Most had switched to online education successfully without it adversely affecting their students. In fact, some students appeared more motivated and focused during the switch. However, the additional work of learning new technologies and adjusting lessons and materials was seen by many as challenging.

While technological innovation in the face of the pandemic undoubtedly enjoyed a degree of success in meeting immediate educational objectives, and with students propelled into more self-directed learning, less attention has been paid to students' emotional needs, following reduction in face-to-face interaction. Subsequent evidence suggests the psychological impacts of the pandemic were considerable, with detriments in distress and anxiety documented (Allen et al., 2023). Unanticipated psychological effects also extend to increasing recognition of videoconferencing fatigue (e.g., Bailenson, 2021; Lee, et al., 2022), with the longer-term effects of this unknown. With the shift to online learning following

COVID-19, came a need for practical and emotional support to deal with the transition. Findings from Lemay et al.'s (2023) work highlight the need for continuing engagement to explore how best to support staff and students in online environments. Lemay et al. (2023) also surveyed Nepalese teachers on the switch to online teaching following the pandemic. They found students' and teachers' activities had been abruptly placed online with them forced to learn new skills to participate in education. The rapid transition saw them struggle with poor support, illness, and financial difficulties. As the present study investigates doctoral students' experiences during and in the aftermath of COVID-19, issues of technological and practical support given them is of importance.

The legacy of the pandemic has been a move toward hybrid/blended learning models comprised of both online and face-to-face instruction, permitting regular remote supervision, greater online dissemination of information and a growing space for part-time and foreign students (Kabir, 2022; Truba et al., 2025). With these developments, it can be argued that pedagogical practice is shifting from a traditional linear paradigm to a more social constructivist paradigm, rooted in increasingly student-centred discourses and flexible pedagogies (Boulton, 2019). As suggested earlier, Boulton (2019) believes new learning paradigms must acknowledge students' historical and cultural experiences. The question of how use of new technologies following the pandemic have affected engagement of transnational doctoral candidates is therefore of interest.

In conclusion, the unprecedented disruption caused by the pandemic led to a transformation in how doctoral research was undertaken, and instruction and supervision delivered that will continue to shape scholarship for many years. Figure 3.1 below summarises the stages of technology adaptation in doctoral education following the pandemic

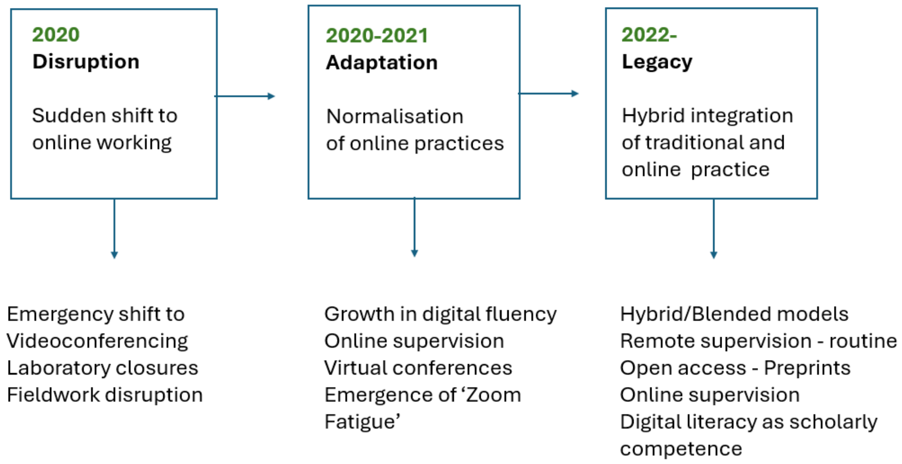


Figure 3.1 Technology Adaptation in Doctoral Education Following the Pandemic.

3.11 Critical Issues in Education Technology

The question, posed by Castañeda and Selwyn (2018), of how we might develop critical perspectives and alternative visions of technology is central to the future of technology in higher education. They believe that framing technologies, solely in terms of their relationship with learning, limits the ways in which digital technologies are understood. They follow Biesta (2009) in contending that approaching digital technologies in this way obscures the social, political, economic, cultural, environmental and ethical aspects of both technology use and educational systems, and further, neglects the socialisation of subjects into these systems.

The danger of such a decontextualised focus on learning threatens to obscure the power dynamics between institutions and government, staff and institutional administrators, staff and students, and institutions and Big Tech companies. All these aspects of power may be significant in determining what kind of learning is desired, what kind is taking place, intended or otherwise, whether learning is deemed to be successful, by what criteria and by whom, where it is taking place and what its consequences are (Chen, 2022; Marshall et al., 2024).

Castañeda and Selwyn argue that neoliberal values are embedded in contemporary education, whether or not it is digitally based, and threaten the quality of education which is delivered and the values propagated alongside it (Roberts, 2018; Andrew, 2024). This is manifest in relation to the question of whether technology is being adopted to meet pedagogical needs or is being driven by an imperative of technological expansion which claims all future problems – including issues of sustainability are amenable to 'techno-solutionism' (Sætra, 2023).

Castañeda and Selwyn (2018) also called for scrutiny of the literature on educational technology in higher education, first, to acknowledge the diversity of technology-based learning and secondly, to theorise learning via the design and use of technologies. They acknowledge that educational use of technology is complex and subject to diverse pedagogic as well as economic actors and influences. This raises questions about how to analyse the use of digital media technologies- including AI - at universities, and the educational processes and commercial interests they serve. Per force, this must consider effects of technological systems not just on the individuals using them – in terms of knowledge, productivity, and well-being - but also the wider social, ethical and ideological effects which arise from this use. Finally, they stress that analysis of educational technology must consider the emotional as well as the rational, cognitive, and behavioural aspects of education. Thus, a critical pedagogy of technology use in education (McLaren, 2023) must attend to issues of power, inequality, sustainability, privacy and ethics (Williamson, 2017; Kumi-Yeboah et al., 2023; Sætra, 2023). As we have seen, the widespread use of AI introduces profound ethical questions. Technology use is never neutral and how doctoral students themselves appraise it is of primary interest in this research.

3.12 Barriers to Completion of Online Doctorates

3.12.1 Completion Rates

Completion rates have been an issue of long-standing concern in doctoral education. Online doctoral programmes, particularly, have been characterised by low retention and completion rates, with attrition for these reportedly 10-30% higher than equivalent courses in traditional, face-to-face settings (Council of Graduate Schools, 2008; Smith, 2010; Terrell et al., 2012; Bawa, 2016; Graham & Massyn, 2019). Bawa (2016) found that those attending online doctoral programs were 10-20% more likely to quit compared to those on residential programmes. Low doctoral completion rates have been reported in many studies (between 35-60% Miller, 2013; between 20-60% Smith, 2010; between 40 and 60% Cassuto, 2013;

56% Lee, et al., 2020; 50% Studebaker & Curtis, 2021), with lower figures reported in social science and humanities programmes.

As well as high drop-out rates, candidates on doctoral education programmes have longer completion times in comparison to other programmes (National Science Foundation, 2019). To cast light on why students persist or quit, Castelló et al. (2017) reviewed 724 social science doctoral candidates across 56 universities. The more frequent motives for contemplating dropping out, they found, concerned difficulties of balancing work, personal life, and study, alongside problems with socialisation. With respect to the latter, several authors (Jairam & Kahl, 2012; Spaulding & Rockinson-Szapkiw, 2012; Zahl, 2015; Hill & Conceicao, 2020; Council of Graduate Schools, 2020) have suggested social integration is a key factor in explaining levels of attrition in doctoral programmes.

3.12.2 Isolation and Integration

Work has also linked attrition to the isolation students experience from peers and faculty and the accompanying difficulty of creating a constructive, supportive virtual community. This is particularly important for online students who are often less able to interact socially (Bawa, 2016; Van Wingerden, 2024). In addition to isolation, a recent review (covering 2013-2023), identified a lengthy series of potentially contributing factors. These include learner motivation, health concerns, financial limitations, workload, support services as well as the quality of technological systems, information and services (Rahmani et al., 2024).

Lack of integration, related to negative stereotypes and representations of ethnic minorities and women, has also been linked to doctoral completion rates (Ostrove et al., 2011). Kramaraw (2003, p. 269) observed that the online setting is “yet another institution where gender and power differences are constructed, and that to ignore the ways that gender is under construction online is to ignore many difficult experiences of real people." It has been suggested that minority groups and women benefit from online support groups and classes, where they feel comfortable to share challenges, accomplishments and sacrifices as a way of encouraging others and cementing their presence in the higher education environment (Marso, 2006).

Drawing on persistence theory (Tinto, 1993), Rockinson-Szapkiw et al. (2019) sought to determine the variables linked with programme integration for online EdD students. A 32-item self-report instrument was used to measure faculty integration (how satisfied students were with the quality and nature of their faculty interactions), student integration (satisfaction with peer interactions), and curriculum integration (satisfaction with the doctoral curriculum's quality and relevance). Regression analysis found programme and personal issues significantly affected candidates' programme integration. Male and white participants also reported greater programme integration than female and non-white participants, suggesting that male and white-dominant social structures govern the online higher education environment, just as previous studies have found them to dominate residential environments (von Prummer & Rossie, 2001; Gardner, 2013; Rockinson-Szapkiw, et al., 2017; Ward & Wolf-Wendel, 2017). Despite this, Rockinson-Szapkiw et al. (2019) found that women comprised the majority in online educational doctoral programmes, where 174 of the 232 participants were women (and 179 were white).

Gaining insights into how programme integration is influenced by personal and programme issues –which in turn influence attrition, may encourage interventions to improve satisfaction with curricula, aid peer and faculty integration, and doctoral candidates' motivation (Rockinson-Szapkiw et al., 2019). A further potentially important set of issues in this context concerns students' personal emotional reactions to technology use, including the possibility of unhealthy or compulsive use of the technology –referred to in some quarters as internet addiction (Morahan-Martin & Schumacher, 2000; Ashford et al., 2018; Simsek et al., 2019; Moreno et al., 2022) and whether or how such use impedes study progress and completion.

3.12.3 Relations with Supervisors

Previous work has documented how compatibility between supervisors and students affects candidates' persistence and integration (Golde, 2005; Lovitts, 2008; Leijen et al., 2016; Litalien & Guay, 2015); it has been considered by some to be the most important factor, with frequency and quality of supervision (Cornér et al., 2023) and social support cited as critical (Corcelles-Seuba et al., 2023). Problems in the supervisor-student relationship can also be compounded by insufficient technical support and opportunity for digital training (Wollast et al., 2018; Rahmani et al., 2024).

It has been reported that female doctoral candidates benefit from female supervisors who are perceived as receptive to making accommodations to their life challenges (Rockinson-Szapkiw et al., 2017). Several authors have found integration and persistence to be associated with women's ability to balance family and academic work and to integrate their gender and ethnic identity into a developing identity as a scholar (Rockinson-Szapkiw et al., 2018; Rockinson-Szapkiw et al., 2017). Rockinson-Szapkiw et al. (2019) argued that gender and race should be considered when mentoring interactions in online doctoral programmes. The extent to which such concerns are voiced by participants in the current study is of interest. Furthermore, the current study considers students' relationships with peers and supervisors, including how these are related working alone in what has frequently been a non-face-to-face environment due to the pandemic.

This brief review indicates there are diverse barriers to programme completion, involving technological, institutional, supervisory, social, personal, and cultural factors, with these likely to be often intertwined. Finally, given the long-lasting effects of the pandemic, and the social isolation which accompanied it, the literature suggests the switch to online learning could have affected retention rates, although the evidence for this is not yet in. If online doctoral programs are to fulfil the aim of being accessible, inclusive and successful then institutions will need to consider the available means they have to address current obstacles.

While much of the literature discussed here concerns fully online doctoral programmes, their relevance to the present study lies in how structural and relational dynamics, such as isolation, mediated supervision, and reduced informal contact are addressed. These increasingly characterise doctoral study even within ostensibly campus-based programmes.

3.13 Summary of the Literature Review

The chapter has discussed doctoral education in relation to the impact of digital technologies on study, supervision, and identity construction. In reviewing the literature, it is evident that doctoral education is increasingly technology driven. The current interest in technology's role in doctoral study has historical roots in distance learning, the evolution of scholarly training and the socio-technical approach to systems. Historically, training was under the guidance of a seasoned 'master' with independent scholarly activity atypical. Now an established worldwide network of scholars exists, which doctoral students aspire to join. Gaining access to this community constitutes a social rite of passage and a reward for demonstrating a high level of specialist disciplinary knowledge. This rite of passage usually involves mentoring and peer support and is aided by communications technology, which has increased in importance in the pandemic/post-pandemic higher education environment. The social aspects of this journey, if successful, may facilitate a transformation in how students see themselves, acquiring through the process, a new identity. Moreover, attention to the social processes surrounding technology use - a legacy of the socio-technical systems approach - may influence how technology is used, both by current doctoral students and future generations. To date, relatively little attention has been directed toward this relationship between the technological and social elements which, when functioning well, can be of obvious benefit, not only to PhD scholars, but also the wider academic community. Maximising the way in which the human element interacts with the technological and in turn is enhanced by it, is of great importance.

Several key themes have emerged from the review. One concerns the role of technology over the duration of doctoral education – from admission, through training, data gathering, writing up and completion. A second, as described above, addresses the social and socio-cultural dimensions of doctoral education including issues related to inequalities of access. A third theme details barriers to accessing education technologies and remaining in doctoral study. Finally, research points to risks to academic integrity, notably in relation to the emergence of AI, as well as ethical concerns around data privacy, and the effects of technology use on well-being.

In conclusion, evidence reviewed suggests that while the digital transformation of higher education in general, and doctoral education in particular, promises numerous benefits – greater access, flexible learning and increased research productivity for example, it brings in its wake several challenges, pertaining to well-being, equality, ethics and the communal nature of academic life. The picture emerging from the literature is of the need for in-depth investigation of technology use by PhD scholars, and their appraisal of it, with an appreciation of individual differences. An enquiry into PhD scholars' computer education, by itself is not sufficient. The review suggests that whilst technology occupies an increasingly central role in doctoral education, critical questions and unsettled debates remain. Several key gaps in the literature can be discerned; limited attention to the emotional dimensions of technology use; insufficient integration of institutional context; and a lack of doctoral-specific, post-pandemic empirical work. One aim of this study is to address these issues and debates through empirical studies utilising both quantitative and qualitative methods. The following chapter discusses the available paradigms for the study, as well as the methodological and theoretical positions which inform the design and execution of the study.

Chapter 4: Paradigms and Methodologies

4.1 Introduction

Research methodology comprises more than the technical procedures followed, and techniques employed for data gathering; it also includes the intellectual assumptions, frameworks, and design considerations that structure research activity (Pring, 2000; Stahl, 2007). In this chapter the epistemologies and methodologies which form the foundations of the current research, alongside its underlying ontological assumptions are considered. In doing so it provides the framework through which existing shortcomings in the literature are addressed, and a justification for the application of a mixed-methods approach. These have been considered a transformative paradigm for circumventing problems which arise when attempting to shoehorn research into categories which are neither exclusively scientific nor non-scientific (Cohen et al., 2018). Furthermore, how the adopted design facilitates the research goals and questions will be presented.

The ontological positions adopted by researchers are not testable (Guba & Lincoln, 1994); they signal researchers' views about the nature of reality (Grix, 2002) and form the basis for the research paradigms employed. A paradigm can be considered a set of agreements and beliefs about how researchers approach problems, and how answers to these are framed (Kuhn, 1962). It is principally described by its ontological, epistemological, and methodological characteristics (Guba, 1990). Ontology concerns the nature of truth, facticity, or reality and the system of concepts employed to articulate these in a given domain (Hudson & Ozanne, 1988; Heidegger, 1999), while epistemology, the system of knowledge, refers to the relationship between the researcher and the object of their study, and how they articulate knowledge of reality, in the language they use (Carson et al., 2001).

This chapter does not intend to offer an exhaustive account of educational research paradigms. Rather, it seeks to demonstrate why a social constructionist framework provides the most coherent epistemological and methodological grounding for examining doctoral students' technologically mediated practices, meanings, and well-being. The discussion proceeds by outlining alternative paradigms before demonstrating their limitations in relation to the present study's aims.'

4.2 Ontological Assumptions

This section distinguishes between ontological assumptions concerning the nature of reality and epistemological assumptions concerning how that reality may be known, interpreted, and represented within educational research. Ontological assumptions in educational research have been widely discussed (Rappleye & Komatsu, 2020; Holmes, 2020) with the competing paradigms of positivism and interpretivism constructed from these assumptions. These have been fiercely debated (Munoz-Najar Galvez et al., 2020, with each associated with specific research methods, tailored to answer distinct types of research questions (Gage, 1989; Newby, 2010).

The current study deals with how doctoral candidates engage with technology in their learning, the sense they make of these activities, and how these interpretations inform their study. Several ontological viewpoints - positivism, critical realism, social constructionism and interpretivism/relativism exist to be considered for the present study. These are discussed below, leading to the decision on which position the current research project is based on, and which set of methods is employed.

4.2.1 Positivism

In examining different ontological assumptions, a key issue is the epistemological goals embodied, whether, for example, to seek explanations in terms of causal relationships or in terms of meanings actors ascribe to events in making sense of the world they live in. Scholars trace the origins of the modern scientific method to Descartes and Bacon in the 17th century. Their epistemological stance held that truth was manifest in the workings of nature, with careful observation necessary to reveal it. The philosophies of empiricism and positivism which emerged stressed the role of observable facts in developing knowledge (Chalmers, 2013). Bacon set out how, through observation and inductive reason, truth could be discerned. Following Bacon, Comte developed the philosophy of positivism, arguing that scientific advances depended on the exactitude with which nature was described. This stressed the mathematical precision with which concrete phenomena are described (Lenzer, 2017). Reason and observation thus became twin pillars of the new scientific method. Later positivists asserted that knowledge arose by verifying propositions derived from observation and that natural laws could be deduced and inducted from these (Guba & Lincoln, 1994).

The prime ontological belief in positivism is that facts exist independently of the observer (Guba & Lincoln, 1994). Positivists largely employ experimental methods, quasi-experimentation, surveys, and questionnaires (Gage, 1989; Park et al., 2020).

Critics of positivism assert it cannot account for how scientific knowledge changes and question the ethical imperatives within it that prioritise measurement and control, and which reduce people to 'measurable entities' (Stahl, 2007). A major problem for positivism is that human experiences and feelings are neither observable nor directly measurable. For a research programme where there is a focus on doctoral students' emotional responses, subjective evaluations of technology, and context-dependent interpretations of academic progress this is a major limitation. The contention that observations reveal truth was challenged by Popper. For Popper (2014), knowledge progression depended upon making key predictions, from within a specified theoretical framework, which were open to refutation. Besides falsificationism, positivism is critiqued from perspectives which characterise modern and post-modern approaches to knowledge, such as social constructionism. These critiques connect to the philosophies of Plato (Taylor, 2013) and Kant (Wicks, 2014).

4.2.2 From Plato and Kant to Social Constructionism

Plato likened our experience of the world to a shadow cast on the wall of a cave by an unknowable reality beyond it. This distinction between shadow and reality and the limitations to knowledge implied by it was reconceptualised by Kant (Wicks, 2014). For Kant, access to reality is dependent on sensory information. He distinguished 'phenomenal' reality from the 'noumenal' reality presumed to exist beyond our perception. Kant argued that the concepts of space, time, and causality, through which we make sense of the world, were constructs, pre-existing in our mental apparatus. The inaccessibility of noumenal reality, means these *a priori* constructs set limits on reason. Kant's ideas are a forerunner of the view that humans are active agents in making sense of the world.

This view, recognised today as social constructionism (Burr, 2024), affords a central role to humans in epistemology, but it also functions ontologically in asserting reality is socially produced. It extends Kant's premise of the importance of biologically given cognitive structures, to the weight of our collective historical, social, and institutional existence. Social constructionism provides a framework within which people's views and beliefs can be examined and is one suited to how doctoral candidates make sense of their relationship with technology. This acknowledges the influence of researchers' beliefs and values on observation, accepts knowledge of reality is imperfect and not neutral (Alvesson & Skoldberg, 2009), and that researchers must be reflexive in examining their stance in relation to the social institutions of knowledge. Such reflexivity situates the researcher in a given field, within a social, historical, and cultural context and informs how influences from these can be considered and addressed. One consequence of this is that belief in the socially constructed nature of knowledge is central to developments from positivism. These highlight relationships between researchers and participants and between both and wider society. With this, the cultural significance of knowledge has grown in importance. This is central to the social constructionist stance examined next.

4.2.3 Interpretivism and Social Constructionism

In educational research, interpretivist approaches are often adopted in preference to positivism (Cowling, 2016). These hold that people cannot be separated from the statements they make; each person constructs their own meanings, constrained by the social and historical traditions within which their knowledge was generated (Gage, 2009). In the interpretivist view, the inter-subjective positions occupied by participants reveal the realities they experience. Hence, interpretivists largely subscribe to a relativist ontology (Alharahsheh & Pius, 2020).

In the present context an interpretivist framework incorporates two key perspectives. Firstly, it permits technology use to be viewed as a distinct culture; secondly, it embraces the variety of perspectives users bring to their interactions with technology, stemming from their own cultural background. This is possible because both information technology culture, and the wider culture, are rooted in the same relational, linguistic, symbolic order. Cowling (2016) argues that in stressing the interactive, inter-subjective nature of situations under study, interpretivism permits a nuanced view of social research methods. Students' interactions with technology are not limited to the materiality of bodies in conjunction with machines, but with motivated, emoting subjects, engaged in actions, for reasons both conscious and unconscious. Appreciating participants' "personal theories of knowledge" as they interact with technological systems (Cowling, 2016, p.55) lies beyond positivism. It can, however, be accommodated within an interpretivist, constructionist perspective (Williams, 2024).

As interpretations of issues or events change, it becomes necessary to note how interpretations are situated, in terms of individuals' personal histories and the shifting parameters of the social situations they live in. With many doctoral students transitioning to independent researchers, the present study opens a space for understanding how technology may facilitate this, as well as how students may respond to technological developments. That differences between people exist does not exclude the possibility that underlying patterns can be discerned. In fact, discoverable patterns in people's utterances and perceptions may reveal much about contemporary social reality. The interpretivist stance, however, makes no assumptions that any 'core reality' is discoverable. Its concern is to navigate participants' perceptions and world views, to make sense *en masse* of these perspectives, while suspending or bracketing belief in a single underlying reality (Dean, 2018).

A further feature of interpretivism concerns the role of language in representing reality. For interpretivists and constructionists, language does not reveal objective truth. Language represents a unique cultural-historical perspective. For Potter and Wetherell (1987), it represents the world and functions in it, as a form of social action - a tool through which people create shared knowledge. The pathways to this knowledge which constitutes consensual reality may have multiple origins. The task for interpretivists and constructionists is to recognise these and their impact on the development of shared meaning in a given context, which in the present study is the technology-mediated field of doctoral study.

Whereas interpretivism prioritises understanding subjective meaning, social constructionism extends this concern by situating meaning within historically contingent discourses, institutional power relations, and shared normative frameworks. Allied to interpretivism, social constructionism addresses how people create meaning in interactions with others and with societal institutions. This includes interactions with institutional products, which include technological artefacts (Douglas, 2012). The totality of interactions governs how people view themselves and the world and underpins construction of everyday knowledge (Berger & Luckmann, 1967). For Jackson and Sorenson (2016) social constructionism provides a framework, in which social reality is shaped by actors through beliefs, ideas, and language, rather than material factors alone. To comprehend people's relationship with technology, the primary aim of this study, requires acquaintance with their personal and shared views and close attention to the language used to express meanings which technologies hold. These meanings form the basis for understanding the place which technology has in doctoral students' lives and how identities are constructed in relation to it.

For researchers, reflexivity is necessary to examine one's position and values in relation to both participants and the methods employed. As researchers may be similarly situated to participants, regarding technology use, they may bring their own situated understandings to aid interpretation of findings (Rapley, 2018). With the recognition that knowledge is shaped by context and in turn, the observer's standpoint, the reflexive stance may slide into relativism - accepting that because multiple perspectives exist, bringing them under a single reality may be problematic (Pring, 2000). This view is useful when considering interpersonal relationships, and particularly the perspectives of marginalised, disenfranchised, and underrepresented people. Acknowledging these views is a useful counterpoint to dominant narratives derived from powerful institutional actors (Cromby et al., 2013). While the present study is not focused on minority voices in students' encounters with technology, it remains a possibility that narratives connected with issues of power may emerge. Where relativism is deployed as a perspective denying existence of any universal truths – 'absolute relativism' - it runs the risk of self-refutation. If all truths are relative, then the truth of relativism itself cannot be universal (Lockie, 2003). While interpretivism homes in on the importance of meaning, it cannot explain that meaning without recourse to real existing structures, such as language and social institutions, which themselves cannot be reduced interpretation – hence it is predicated upon a disavowed realist ontology (Bhaskar, 1979; Archer, 1995; Danermark et al., 2022).

Researchers practising interpretivist and/or constructionist approaches typically use qualitative methods with a focus on an individual's subjective position. The researcher adopts a stance of intersubjectivity in relation to the participants, where the researcher's subjectivity exists in relation to participants' subjectivities (Fay, 1996, William, 2024). This intersubjectivity enables the creation of a consensual reality through exchange of beliefs, opinions, practices, and knowledge (Parker & Shotter, 2015). To complement the creation of this intersubjective field, different (mixed) methods can be employed to synthesise and seek convergence across data sources. Engagement with meaning does not preclude quantitative methods, as these facilitate knowledge of the patterned exteriority and context of social life which individuals must contend with in constructing their views of reality (Scott, 2005;

Clark, 2019). Such mixed-methods research benefits greatly from a social constructionist perspective (Romaioli, 2022).

4.2.4 Realism, Constructionism and Interpretivism

Combining Kant's transcendental realism with contemporary critical theory, critical realism (Bhaskar, 1979; Chalmers, 2013), subscribes to the ontological assumption that reality exists, and an epistemological stance that direct knowledge of reality is impossible. Realist models in the present context assume that the factors shaping doctoral education – the socio-technical environment, digital infrastructure, the onset of the pandemic, and emergence of ChatGPT in the midst of the study - exist beyond individual perception. As constructionists have argued, knowledge of these conditions is always partial and is mediated by history, context, language and interpretation, consistent with post-positivist understandings of inquiry (Maxwell, 2012).

For the mixed-methods design used in this study, therefore, critical realism provides a suitable ontological grounding which permits quantitative analyses to elucidate patterns in students' engagement with technology, acknowledge the role of technology companies and institutions in shaping the technological environment at the same time as acknowledging that lived experience and doctoral students' subjective views about their engagement can be accessed interpretively through interviews. The world therefore can be comprehended through construction of cause-and-effect relationships based on empirical observations, *and* by ongoing meaningful interrogation, enabling researchers to build *meaningful* concepts from the data they encounter from both sources. Hence social constructionism in this context provides the epistemological basis for making sense of the data.

Social constructionists believe that, whilst useful and meaningful to speak of 'facts', these are grounded in existing systems of knowledge, representation and power. Phenomena, Sayer (2000, p.17) writes "are intrinsically meaningful" and our research constructions of them are "externally descriptive" and "constitutive" of reality. Thus, "there is always an interpretative or hermeneutic element in social science." This hermeneutic element can be approached by several methods, from surveys to interviews, together enabling a more thorough understanding of the *situated* meanings participants provide.

From a critical realist perspective, models are meaningful structures which map, imprecisely, onto observable phenomenal events. From a constructionist perspective, they seek to build a consensual reality, with new views intent on challenging existing areas of consensus and facilitating consistency and improved correspondence with knowledge structures. From a critical perspective the models exist in relation to dominant discourses (Burr & Dick, 2017). While observers view events from specific temporal, spatial and cultural vantage points, no-one can claim an unbiased perspective. To the extent we inhabit a reality, constructed from shared assumptions, beliefs and customs, expressed individual views form the primary domain of qualitative investigation with language central to what is communicated.

The benefits of critical realism in this study are 1) that it supports the methodological pluralism of a mixed-method study, 2) can engage with the situated meanings of doctoral students' technology use at the same time as viewing technological tools as ontologically real - which people engage and interact with and construct meaning about – and 3) address the changes in practice and meaning which have been instigated by the pandemic and the introduction of AI. This ontological framework and its relationship to the theoretical position adopted in the present study is outlined next.

4.3 Theoretical Framework

In examining doctoral students' use and appraisal of technology, a synthesis of socio-cultural (Vygotsky, 1986) and socio-technical (Ropohl, 1999) perspectives is valuable. Both suggest information is gained within specific social, historical, and cultural context and provide a foundation for exploring the structural and experiential dimensions of doctoral education. As both inform the research questions and methodology employed, they will be briefly discussed, beginning with Vygotsky's work.

Vygotsky's (1986) approach represented a radical shift from Piaget's constructivist viewpoint, which hypothesised children's cognitive development passed through a series of maturational stages. In contrast, Vygotsky stressed the role of the social environment and the learner's interactions within it, in advancing knowledge and development. As his views have much in common with later social constructionists (Burr, 2024), Vygotsky is seen as a pioneer in socio-cultural theory, creating conceptual tools that informed the development of social constructionism as a theory of knowledge (Kvale, 1999). For Vygotsky, knowledge was a social product nurtured through interaction, with learning progression dependent on the environment and how this could be 'sculpted' to aid conceptual advances. Vygotsky envisaged the learner operating within a 'zone of proximal development'. With appropriate instructional 'scaffolding' (Wood et al., 1976), from more capable peers or teachers, using suitable environmental and technological tools, the learner could move beyond their current knowledge level. This perspective emphasises the role of others in developing an individual's learning. Importantly, Vygotsky's approach envisages no predefined endpoint when learning is concluded. Accordingly, it enables learning, with and through others, to be viewed as a potentially lifelong process and thus is pertinent to doctoral students' use of technology, notably in collaborative group settings such as forums, conferences, and research groups. Furthermore, others may guide the learner in interacting with and changing the environment. As the environment is intrinsically linked with what is learned and how, it is a small step from this to the development of socio-cultural theory. A key premise is that human learning always involves the culturally situated use of tools (Säljö, 1999); be they material, conceptual or symbolic, ranging from artefacts such as computers, through to language. These concepts form a useful background to understanding doctoral candidates' engagement with technology.

In addition to framing learning as a socially situated use of tools, social constructionists argue that how people interact with technology has implications for self-identity. Gergen (1991) discussed the role of pre-digital communication technologies in shaping his identity as a writer. In doing so, he stressed the role of language in the socially constructed meanings central to sense of self, aligning oneself with friends, and situating oneself culturally. This is possible because language carries a repository of social, cultural, technological, and institutional resources (Perley, 2011). Thus, it is not only how people physically interact with technologies that is significant but how interactions are discussed and relayed symbolically through language. This is relevant to how doctoral students construe their identity within the academic community.

4.4 People and Technology: Socio-Technical Systems and Socio-Cultural Theory

Socio-technical theory proposes technology shapes social structures and is shaped by them. As indicated, socio-cultural theory posits that learning and identity are mediated by tools, language and cultural practices (Vygotsky, 1986). Together they explain how doctoral students' engagement with technology is socially constructed whilst being structurally and institutionally shaped. The socio-technical approach emphasises the inter-dependence of technical and social systems – with social factors envisaged as technological constituents in an institution (Trist et al., 1963). It recognises that technology also requires explanation and contextualisation in terms of the social systems into which it is etched (Pinch, 2012).

The ways in which technology influences people has been considered through technological determinism, whereby technology directs learning practices and shapes development of community around itself (Jones, 2001). In contrast, the social development of technology emphasises technology as a mediator in human connections, with social activity influencing technology use, and technological artefacts understood as social constructs (Pinch & Bijker, 1984; Gupta et al., 2024). These viewpoints aid in contemplating the relationship between technology and people, with the socio-technical framework offering a potential resolution to any difficulties. It has been applied to a range of systems (Kanger & Schot, 2019) and merges creative and social aspects of technology use with its mechanical/functional features, allied to its institutional basis (Lee, 2018). For Baxter and Sommerville (2011) the socio-technical approach enhances the technology experience for end users, although this assumes technological developments are primarily engineered to benefit users rather than the corporations that design and implement features in systems, irrespective of the wishes of those who use them (Zuboff, 2019).

The socio-technical framework conceptualises a dynamic system comprised of technical and social elements (Errey & Liu, 2006; Blayone, 2019). Both impersonal information processing and human decision-making are co-present. As doctoral students engage with institutionally provided technology, they seek to make sense of and contend with technological systems in continuous development – requiring a process of perpetual adaptation (Karanasios, 2018). The socio-technical framework thus incorporates an historical dimension, enabling evolving organisational, technical and hermeneutic aspects of a system to be considered (Baxter & Sommerville, 2011). This is relevant for the present research as it focuses on the two-way relationship between PhD students and technology. Experienced technology users may inspire modifications in how future learners approach it, contributing to technological development and establishment of new norms and standards.

While in its original form socio-cultural theory focused on child learning, its contemporary applications extend to adult learning, identity formation and digitally mediated practices. From the socio-cultural perspective, a doctoral study programme can be described in terms of (a) the tools (technologies) utilised by actors (students/supervisors), (b) the institution where training occurs, (c) the field of study, (d) set of principles/guidelines, (e) the community, (students, academic staff etc.), perceived connections amongst them and goals pursued, (f) division of labour e.g., supervision, support, study, library assistance) and (g) the outcome - experience and knowledge gained (Engeström, 1987). Essential to PhD study are students' ongoing sense-making activities in response to the structured, situational demands they encounter, which may include how they identify with the academic community (Mendoza, 2007), with its codes of conduct, beliefs, customs and instruments, all of which are open to interpretation.

The socio-technical perspective provides a framework for understanding how people learn to work with technology and sees human capabilities evolving through specific 'object-oriented' practices (Engeström, 2009). The tools aiding the learning process – both external (technological) and internal (cognitive-emotional) – can be viewed as key co-constructed elements (Engeström, 2009; Bligh & Flood, 2017). The system of meanings governing technology use are thus fully compatible with hermeneutic approaches. Furthermore, the characteristics of this socio-technical system depend on the stakeholders, students and supervisors, who collectively engage with the work, the nature of the work itself, together with the cognitive strategies and meaning making employed in pursuing scholarly goals. Consequently, although each PhD programme is different, the search for meaning is common to all (Granata & Dochy, 2016).

Although socio-technical systems and socio-cultural theory have roots in distinct traditions, they are complementary in important ways. Socio-technical theory emphasises how institutional systems and technological infrastructure shape students' technology practices. Socio-cultural theory, in contrast, illustrates how individuals interpret, adapt and assign meaning to technology use. Together they comprise a cohesive framework for investigating both the patterned-structural and experiential aspects of doctoral students' technology use. In the present context, they function as mid-range frameworks that operationalise social constructionist assumptions, emphasising the reciprocal shaping of human agency, institutional structures, and technological systems.

4.5 Chosen Theoretical Framework: Social Constructionism

Students' engagement with technology entails a continual process of constructing meaning within an institutional, social context, one which can be appropriately captured through a social constructionist perspective. To recap, social constructionism posits social reality is negotiated and actively constructed through language, interaction, and shared cultural practices (Berger & Luckmann, 1967, Burr, 2024). This stresses the subject positions of participants, the shared meanings they construct in interacting with one another and with technology, and the reflexive stance of the researcher. From a purely constructionist perspective, the technological world, as understood, is held to be constituted through meaning.

For Berger and Luckmann (1967) reality is experienced and interpreted through a social lens; thus, for them the subjective constitution of reality was as important as objective reality. They maintain collective understanding of reality in any cultural domain can be considered an outcome of both primary (pre-institutional) and secondary (institutional) socialisation. The current research, embracing the socio-cultural dimension to technology use alongside socio-technical institutional constraints is a pragmatic accommodation of social constructionism to real structural constraints within which technology is developed, utilised and understood – which includes both the pandemic and introduction of AI - and within which doctoral students conduct research. Such accommodation to a realist framework has a long history in social constructionist theorising (Proctor, 1998; Hastings, 2002; Marshall et al., 2005; Puddephatt, 2022) and enables the current research to practically and flexibly accommodate critical realist and hermeneutic perspectives; to be responsive to how doctoral students negotiate technology use and invest it with meanings which are not fixed in the technology. It can do this, while recognising patterns of technology use are situated within industrial, institutional and cultural contexts, thus bringing together the structured analysis underpinning socio-technical theory with the hermeneutic aspects of students' subjective responses to technology. These meanings can be viewed as products of academic socialisation and intrinsic to the contemporary postgraduate technological world. Interpretivism alone, unanchored from a realist ontology, cannot address the embeddedness of these meanings in contexts of structure, power and transformation (Junjie & Yingxin, 2022; Blau, 2024). The emergence of both COVID-19 and ChatGPT –which have shaped the technological landscape and meaning making of doctoral students in the present study – thus make interpretivism an unsuitable epistemic framework. By grounding the current research in this biological and technological real-world context, the philosophical discussion presented gains practical relevance and coheres with the study's overarching aims.

The following chapters build on this foundation, with the study situated within a critical realist ontological framework and employing a social constructionist epistemology. In the next chapter, the mixed-methods (survey, interview) and procedures that were employed in addressing the research aims within the chosen paradigm are presented. Each method is presented with brief justification for why specific research instruments were used for data gathering. Following this, the results obtained from the application of these methods are presented.

Chapter 5: Methods

5.1 Explanatory-Sequential Mixed Methods

This chapter deals with the research methods employed in this study. This describes how the mixed-methods (survey and interview) approach was implemented, alongside the respective sampling techniques, data gathering processes followed, the analytic procedures used, and the ethical issues present. This design was adopted in order to examine both patterns of doctoral students' technology use, and the meanings through which these patterns are interpreted and enacted. The quantitative phase focuses on addressing the question of PhD students' productivity and effectiveness. It examines how they utilise technology in their study habits, not just in relation to their perceived educational success, but also with respect to the social networking and support opportunities provided. How they deal with the challenges which they confront during their studies – those clearly technological in nature as well as those driven by technology – are a key concern. The qualitative phase was designed to illuminate the situated sense-making processes underpinning these findings. A central aim of the thesis then is to understand doctoral students' study habits, their views toward technology and the role it plays in their learning.

The methods employed are consistent with the study's critical realist ontology. This holds that technological systems, institutional structures, and the pandemic exist independently of students' perceptions and produce real effects. The design also reflects the study's epistemological position – that real effects are subject to interpretation, with a social constructionist stance utilised to frame the meanings which participants create.

The research questions (Chapter 1) guiding the research are restated below.

1. How do doctoral students employ digital technologies to research literature and collect data? Are there systematic differences in how students use and evaluate technology?

2. What perceptions do students have regarding the beneficial and adverse effects of technology on their study tasks?

3. Are there identifiable patterns of technology use in diverse settings that differentiate those who feel productive from those who do not?

4. To what extent does technology facilitate/hinder effective communication with others, including fellow students, teachers, and supervisors? For example, do students prefer feedback face-to-face or mediated through technology?

To address these questions an explanatory-sequential mixed-methods research design was employed, with one quantitative and one qualitative investigation conducted within the same programme (Bergman, 2008; Kajamaa et al., 2020). Research Questions 1 and 3 were addressed through the survey and associated inferential analyses. Research Question 2 was addressed through both survey items and interview questions, while Research Question 4 informed the communication-related survey items and the design of interview prompts exploring mediated and face-to-face interaction.

Mixed methods are increasingly employed in educational research (Johnson & Christensen, 2017; Cohen et al., 2018; Corr et al., 2021), offering complementary approaches, enabling triangulation and cross-validation of data obtained using different methods (Greene et al., 1989; Ponce, & Pagán-Maldonado, 2015). The design is informed by critical realist and pragmatic considerations, in which the research questions and methods used for addressing them are primary concerns (Johnson & Onwuegbuzie, 2004). This enables both structural patterns of data use and the lived experiences of doctoral students to be considered.

The two phases of the study comprise an initial cross-sectional survey providing descriptions and analyses of students' views and use of technology, followed by individual interviews with a subset of participants who had completed the survey and agreed to be recontacted for interview. The design of the interviews is guided by and informed by the survey results with the aim of providing semantically rich data for understanding how students make sense of the technological world they inhabit (Creswell & Plano Clark, 2017). The presentation of the quantitative findings first is thus consistent with the logic of the design and clarifies the rationale for the ensuing qualitative interviews and specific questions asked of participants.

Data were gathered from doctoral students at the University of Glasgow, Scotland and predominantly from other universities across the UK. An opportunity sample of PhD students were recruited from various academic fields, at different stages of study. The detailed methods for each phase of the study are presented below. Following presentation, in this chapter, of the methods for the survey and interviews, Chapters Six and Seven present the results and discussion of the survey with Chapter Eight dealing with results from the interviews, and Chapter Nine, integration of findings from the survey and interviews.

Finally, in Chapter Ten, overall conclusions are presented, together with evaluation of the study's strengths and limitations and final reflections on the role of the researcher.

5.2 Study Part One: Cross-Sectional Survey

5.2.1 Design and Methods

A cross-sectional survey design was employed. The survey investigated technologies used by participants and whether the tools used, and issues faced with them, were felt to help or hinder the progress of their studies. The survey questions were designed to gather a broad range of information, to ascertain general trends in technology use, and to inform the design of the later interviews. Surveys have advantages in questionnaire delivery and data collection (Connelly, 2016; Nayak & Narayan, 2019) and permit considerable data to be collected relatively quickly. It was hosted on the Online Survey platform (formerly BOS) and organised in several sections (see below), following a logical sequence (Glastonbury & MacKean, 2020), with a mixture of closed and open questions designed to produce high-quality responses amenable to quantitative and qualitative analysis (Lupu & Michelitch, 2018). The online format facilitated participation by both UK-based and international doctoral students regardless of geographical location.

5.2.2 Participants and Sampling

With linear regression analyses utilised as a major analytic tool, calculations in GPower3.1 (Verma & Verma, 2020) suggested a minimum sample size of 263 as sufficient for detecting small effect sizes (f^2=0.05) in a regression analysis with five predictors, at a statistically significant level (alpha=0.05) with 80% power.

An opportunity sample of 310 participants currently engaged in doctoral study was recruited by sending emails to several sources: the Postgraduate Student Association in the Education Department of Glasgow University, supervisors of doctoral students, and Heads of Department in departments of Education, and Psychology throughout the UK. These were contacted after compiling a list from university websites. These letters informed recipients of the study's nature and, where appropriate, requested them to forward the email to PhD candidates. Each letter contained a live link to the survey. In addition, direct notices were posted to personal contacts on Facebook, Twitter, and Instagram. Data collection began in November 2021 and continued through to November 2022.

5.2.3 Survey Instrument

5.2.3.1 Materials and Variables

On following the survey link, participants were presented with an information sheet (Appendix 1) and consent form (Appendix 2), after which demographic information was solicited, including field of study - coded into science and non-science subjects, a distinction following Rockinson-Szapkiw et al.'s (2019) demarcation between STEM and Non-STEM subjects. Participants' nationalities were categorised into UK, European, Asian, American/Caribbean, Middle Eastern, African, and Australian. Following UK Government (2021) census guidelines, ethnicity was coded into five categories (1=Asian, Asian British, 2=Black, Black British, Caribbean, or African, 3=Mixed or multiple ethnic groups, 4=White, 5=Any other Ethnic group).

After the demographic section, 93 survey questions dealing with technology use were presented. These were grouped under the following headings: General Software Use and Information Sources, Feelings on electronic usage sources, Data Capture and Collection, Data Processing, Quantitative Research Software, Qualitative Research Software, Presentation Software, Video Conferencing and Communication, Technology & Software (including messaging), Recording Software, Training and Personal Use of Technology (see Appendix 3).

To optimise validity, where possible, the survey utilised some items from existing instruments (see below) with additional novel items. The survey was piloted beforehand for ease of comprehension and appropriateness. Piloting involved a small group of three doctoral students; these being drawn from outside the main sample. Each of these were studying at a UK university within a different disciplinary field and included those with science and non-science backgrounds, a distinction employed by Rockinson-Szapkiw et al. (2019). The intention was to gather data from participants from different disciplinary backgrounds.

Variation by discipline was designed throughout this research project. Following the approach in Rockinson-Szapkiw et al. (2019), the science/non-science dichotomy was incorporated at the very beginning, during survey construction, and consistently used throughout in analyses as a factor in technology use, training, communication preference, and study completion. To examine more fine-grained distinctions in any analysis would of course require a much larger sample size.

The pilot participants were requested to complete the survey and to provide as much detailed feedback as they could on the clarity and appropriateness of individual questions, the instructions provided for responding to these, as well as the flow, length and feel of the survey.

The feedback was obtained through a structured conversation with each of the pilot participants after survey completion. The process revealed a few areas which required attention. As a result, some of the question items were reworded to improve clarity and precision, with changes also made to the ordering of two of the sections to improve the logical progression of the survey. These changes were incorporated before the survey was opened to the main participant sample in November 2021.

The questions on technology use were designed to obtain information on the technological tools used, how often they were used (1=never, 2=rarely, 3=occasionally, 4=frequently), how helpful they were judged to be, and problems encountered with them (problems were listed through open-ended questions). Helpfulness was measured on a 5-point scale in response to statements "Overall, I find the software I use for … helpful" (1=strongly disagree to 5=strongly agree). Feelings when using electronic information sources (frustration, interest, engagement, boredom, anxiety, and relaxation) were reported in answers to a series of statements, also expressed on a 5-point scale (1=strongly disagree to 5=strongly agree). A total score for negative emotions felt when accessing electronic information sources was computed from the summed scores for feeling frustrated, bored, and anxious (Cronbach alpha=.63). Similarly, total score for positive emotions when accessing electronic information sources was computed from summed scores for feeling interested, engaged, and relaxed. Possible scores for summed variables thus ranged from 5 to 15 (Cronbach alpha =.61). Scores for internal consistency are usually desired to be above .70 (Nunnally & Bernstein, 1994; Kline, 1999). However, given the small number of items in each of these scales, and the exploratory nature of the measures, internal consistency for both summed emotional variables can be considered respectable (Nunnally, 1978; Field, 2018).

Having been previously linked to academic and work performance (Britton & Tesser, 1991; Hall & Hursch, 2008; Alyami et al., 2021), several questions were constructed concerning time management. Answers were given on a 5-point scale (1=strongly disagree, 5=strongly agree). The items were 'Spending time online with study affects how much exercise I take', 'Spending time online with study affects my social life', 'Spending time online interferes with the quality of my sleep', 'Spending time online with study affects my family life'. A scale, 'Problems caused by spending time online' was computed by summing scores from these. Total possible scores ranged from 5 to 20 (Cronbach's alpha =.80).

Several items assessed how helpful training was judged to be in several areas of technology use: messaging, videoconferencing, presentation software, subject specific software, spreadsheets, End Note, qualitative data analysis, quantitative data analysis and literature searching. These also displayed good internal consistency (Cronbach's alpha = 0.73), enabling an overall scale score for 'Helpfulness of training' to be computed.

'Range of social media usage' was computed from the number of social media outlets students had engaged with. These included Snapchat, Twitter, YouTube, LinkedIn, Facebook, and Instagram. Total possible scores ranged from 0 to 6.

A section on Health and Well-Being contained previously validated items on self-evaluation of health status, perceived stress and difficulty paying bills (Marmot et al., 1991). Current health (1=poor, 2=fair, 3=good, 4=very good, 5=excellent) and health compared to one year ago (1=much worse than 1 year ago, 2=somewhat worse than 1 year ago, 3=about the same as 1 year ago, 4=somewhat better than 1 year ago, 5=much better than 1 year ago) were assessed on 5-point Likert scales. Perceived stress, defined as "a situation where a person feels tense, restless, nervous, or anxious, or is unable to sleep at night because his/her mind is troubled all the time" was also measured on a 5-point scale (1=not at all, 2=only a little, 3=to some extent, 4=rather much, 5=very much). Difficulty paying bills was also assessed on a 5-point scale (1=none, 2=very little, 3=slight, 4=some, 5=great). These latter items were included as economic circumstances are a known determinant of well-being, with both linked to educational attainment (Marmot et al., 1991; Marmot, 2020; Mistry & Elenbaas, 2021).

Respondents were asked to indicate how the COVID-19 pandemic had affected their studies. Possible answers ranged from 'very negatively' (1) to 'very positively' (5). Satisfaction with study progress was measured on a 5-point scale in answer to the statement "I am satisfied with the progress of my studies" (1=strongly disagree to 5=strongly agree).

Questions on the degree of satisfaction with computing devices used (university supplied desktop, university supplied laptop, own desktop, own laptop, tablet or IPAD and mobile phone) were added at a later stage of the survey. These were measured on a 5-point scale (1=very dissatisfied to 5=very satisfied).

As can be seen from the above, several of the key areas surveyed – notably those which address satisfaction with study progress, happiness with time management, and perceptions of helpfulness, are concerned with aspects of efficiency, productivity and measurable output. These form key areas of concern in contemporary higher education under neoliberal management (Back, 2016). Whilst this environment is subject to critical discussion in this thesis, because students' lived experiences are shaped within the neoliberal environment, it is on occasion necessary to work critically within existing frameworks in order to advance knowledge (Bourdieu, 1990). It is important to stress that the technological world which doctoral students negotiate and navigate is one which is largely situated within institutional structures which prioritise such notions of efficiency. Study progress, time management, and productivity can be understood as operationalised variables which reflect this ethos. Consequently, to investigate students' relationship to technology and how technology affects their experience requires engaging with these categories. This entails a necessary methodological tension in the present work between employing these categories and to contextualise and critique their meaning within higher education institutions. Within a social constructionist framework, it is acknowledged that what students understand as 'progress' or 'effective time management' may themselves be products of the technological and institutional conditions under which they labour.

5.2.3.2 Procedure

Once directed to the website hosting the survey (https://glasgow-research.onlinesurveys.ac.uk/students-perceptions-of-the-benefits-and-drawbacks-of-tec-3), respondents were presented with a Participation Information Sheet (Appendix 1) describing the study, estimated completion time (30-35 minutes), a statement explaining participation was voluntary, that respondents could withdraw at any time and all personal details would be confidential. Contact details were given for the principal researcher and supervisor and a consent form for participants to confirm they had read and understood the information provided and agreed to take part. With consent given (Appendix 2), participants were directed to the survey. It was possible to move back and forth through the survey with the option of answering missed questions later if desired.

5.2.4 Analysis Strategy

The analysis strategy for this phase of the study was directly shaped by its philosophical foundations. With variables assessing use and effects of technological systems, and the effects of the COVID-19 pandemic, both of which are considered to exert real influences on doctoral students' study, the study is able to examine both observable patterns and subjective interpretations.

All quantitative analyses were conducted in SPSS v27.

5.2.4.1 Descriptive Analysis

Prior to detailed statistical analysis, the main descriptive features of the sample are presented, with data summarising the technologies used, perceptions of these technologies, participant's health and well-being, satisfaction with study progress and emotional reactions to technology use. This enabled the broad parameters of respondents' engagement with technology to be established, before analysing the relations between them.

1. The sample is described in terms of age, gender, full-time/part-time status, length of time studying, discipline studied (science/non-science), and nationality (UK, European, Middle Eastern, Asian, Americas/Caribbean, Africa, Australasia).

2. Descriptive statistics are reported for the following areas; information sources (preference for physical v digital copies of books/journals; electronic sources used for information searches), technologically mediated data collection (web-sites and video-conferencing, benefits of technologically mediated data collection), research methodology employed, preferred software platforms for analyses, use of video-conferencing, use of communication/messaging software (preferred software, time/day spent messaging, how lecturers communicate with students; face-to-face v technologically mediated), preference for campus based v online study, training (type of training received, helpfulness of training), time management, health and well-being (current health, health compared to previous year, perceived stress, effect of COVID-19 on studies, difficulty paying bills), social media use, emotional responses to using electronic information sources (interested, engaged, relaxed {positive reactions}, bored, anxious, frustrated {negative reactions}, helpfulness of technology and satisfaction with study progress. In addition, degree of satisfaction with specific items of computing technology is reported.

5.2.4.2 Inferential Analyses

Inferential analysis of survey data focused on several key areas; (1) perceived study progress, (2) the helpfulness and difficulty of using technology, (3) emotions when accessing electronic information sources, (4) time management, (5) health and well-being and (6) communication with lecturers and other students. The use of inferential statistics is consistent with this study's critical realist ontological position. This assumes that measurable patterns and relationships for example between technology use, well-being and study progress reflect underlying tendencies that exist independently of the researcher (Maxwell, 2012).

Wu & Lung (2017) point to long-standing debates on whether Likert scales can be treated as continuous interval scales (Carifio & Perla, 2008) and whether ignoring violations of normality assumptions can be beneficial (Knief & Forstmeier, 2021). Several authors (Borgatta & Bohrnstedt, 1980; Sullivan & Artino, 2013; Harpe, 2015) have argued that treating Likert scales as 'imperfect interval scales' is advantageous, while Norman (2010) found that analysis of Likert scales with parametric tests was robust in producing unbiased answers, despite violations of normality. Their use can also be justified by the central limit theorem which holds that the sampling distribution of means for any distribution is always normally distributed (Field, 2018). Given these arguments, subsequent analyses will utilise parametric methods unless otherwise specified. These analyses include multiple regression/linear modelling, which, Schmidt & Finan (2018) demonstrate, is robust to potential violations of normality, once sample sizes exceed 25.

5.2.4.2.1 Perceived Study Progress

Satisfaction with study progress was examined in relation to variables associated with time management, perceived helpfulness of technologies, training, emotions felt when using technology, problems caused by spending time online, stress, health and well-being, demographic factors (gender, ethnicity, full/part-time status, field of study, country of study) and communication with lecturers (face-to-face v other). Informed by the pattern of correlations with satisfaction with study progress, a general linear model to predict satisfaction with study progress was constructed.

With data collection undertaken over a duration which included removal of COVID-19 restrictions, the model was tested in two time periods. The first covered the period until mid-

July 2022, before all restrictions (lock-down, mask wearing etc.) were removed. During this earlier time, it can be expected that students were more reliant on technology, and more affected by the pandemic. Consequently, an independent t-test was used to examine whether students reported differences in how their study was affected by the pandemic in these two periods. It was also predicted that the model applied during this first period would have greater predictive power.

5.2.4.2.2 Helpfulness and Difficulty of Technology

Correlations were examined between measures of helpfulness of technology in different domains (data collection, qualitative/quantitative analysis, specialist software, videoconferencing software, presentation software, email, instant messaging, technologies for recording lessons, technologies for receiving information). To assess any underlying structure to perceived helpfulness, a factor analysis (with varimax rotation) was undertaken.

5.2.4.2.3 Emotions when Accessing Electronic Information Sources

For the summed variables of negative and positive emotions, the following variables were utilised in the correlational analysis; helpfulness of software for online data collection, word processing, specialist software, quantitative data analysis, qualitative data analysis, presentations, videoconferencing, recording lessons, receiving information, quality of audio in videoconferencing causes discomfort, ever received training in technology use, I find software difficult to use, I prefer face-to-face tuition, satisfaction with study progress, spending more time on the Internet than intended, problems caused by spending time online, happiness with time management, current health, health compared to one year ago, the COVID pandemic has affected my studies, perceived stress, and difficulty in paying bills.

For individual negative emotions, correlations were also computed with feeling interested, feeling engaged and feeling relaxed. For individual positive emotions, correlations were computed with feeling frustrated, bored, and anxious.

5.2.4.2.4 Time Management

Correlations were computed between happiness with time management and the following variables: ‘I tend to spend more time on the Internet than I intended’, ‘Spending time online with study affects how much exercise I take’, ‘Spending time online with study affects my social life’, ‘Spending time online interferes with the quality of my sleep’, ‘Spending time online with study affects my family life', and 'range of social media usage'. The composite variable 'Problems caused by spending time online' was examined in relation to several variables concerning technology use, and with self-reported health and demographic variables.

5.2.4.2.5 Health and Perceived Well-being

Current health status was correlated with variables associated with time management, perceived helpfulness of technologies, emotions felt when using technology, perceived stress, demographic factors, and nature of communication with lecturers (face-to-face v other).

5.2.4.2.6 Communication with Lecturers and with Other Students

Items concerning communication with lecturers and students using videoconferencing and instant messaging software were correlated with satisfaction with study progress and examined in relation to study discipline (science v non-science) and demographic factors.

5.2.4.3 Qualitative Analysis of Open-Ended Survey Questions

Two open-ended questions were asked to encourage respondents_to reflect on their encounters with digital technology. Firstly, having been asked their preferences for campus-based or online study, respondents were invited to explain their choice. Secondly, they were asked to state sources of satisfaction they derive from using technology and what kinds of problems they encounter. For these questions, responses were analysed thematically and coded post-hoc into distinct categories for analysis in terms of their relative frequency. This form of content analysis is widely employed (Potter, & Levine-Donnerstein, 1999; Krippendorff, 2004; Strijbos et al., 2006; Vaismoradi et al., 2013; Fakis, et al., 2014). Table 5.1 provides a summary of the types of instruments used in the survey.

Table 5.1 ***Summary of Instruments Used in Survey***

Variable Group	**Scale Type**
Demographics (gender, age, nationality, discipline)	Categorical
Technology use (e.g. frequency of use, software platforms)	5-point Likert / hours
Helpfulness vs. difficulty (of technology in different domains)	5-point Likert
Emotions when Accessing Information Sources	5-point Likert: Sum of +ve/-ve emotions
Time Management	5-point Likert: Sum problems from spending time online
Well-being & study progress	5-point Likert
Communication & supervision (frequency/quality of digital interaction)	5-point Likert
Open-ended reflections (e.g. satisfaction and problems with technology)	Text response

As mentioned (section 5.1), with the analytic strategy outlined, I now present the methodology for the semi-structured interviews.

5.3 Study Part Two: Interviews - Students' Experiences of Technology

5.3.1 Design

The interview is a flexible and versatile qualitative method, grounded in hermeneutic, idiographic, and contextual analysis and well-suited to understanding doctoral students' perspectives and experiences in depth (Rubin & Rubin, 1995; Wilson, 2012; Tuffour, 2017). Interviews enable participants to express how they understand and negotiate digital technologies within an academic context, and support the production of rich, situated accounts of practice (Wilson, 2012). This aligns with the study's constructionist epistemology, recognising meaning as co-produced through interaction.

Following examination of the survey results and after piloting, a semi-structured interview schedule (Appendix 4) was constructed, incorporating areas of interest derived from the survey which permit exploration in greater depth. The schedule included questions covering the benefits and drawbacks of technology use whilst studying, areas of training received or self-taught, use of videoconferencing, communication, data analysis, personal time management, health, well-being and study progress. With the emergence of ChatGPT subsequent to the survey going online, an additional question was added to the schedule so that interviewees could discuss their use of AI tools.

5.3.2 Participants

Estimating an appropriate sample size when conducting interviews can depend on several factors; data quality, scope of the study, nature of the research topic, interview length, how much useful information is obtained from each participant, and the method used for analysis (Guest et al., 2006; Morse, 2015). In the present study, 16 participants (4 males, 12 females) were interviewed, drawn from natural and social sciences, humanities and education. The coding scheme was attentive to this aspect of disciplinary positionality within participants' narratives.

These had completed the initial survey, consented to a follow-up interview and selected to represent a diverse sample of academic disciplines. The sample size was sufficient to support meaningful thematic development, using reflexive thematic analysis to provide analytic depth, interpretive richness, and reflexive engagement – with these prioritised over claims to data saturation (Braun & Clarke, 2021). Table 5.2 below provides details of the participants. Pseudonyms are given.

Table 5.2 ***Participants in the Interview Study***

Participant		**Age**	**Gender**	**Field of Study**
S1	Harold	24	Male	Biochemistry
S2	Sheila	29	Female	Psychology
S3	Wei	24	Male	Psycholinguistics/Applied Linguistics
S4	Natasha	24	Female	Computational Physics
S5	Maya	28	Female	Pharmacy & Optometry
S6	Christine	43	Female	Education
S7	Christabel	24	Female	Social Psychology
S8	Neville	33	Male	Education
S9	Zoe	25	Female	Politics
S10	Nicola	29	Female	Management
S11	Monica	30	Female	Computer Science
S12	Deirdre	55	Female	Music
S13	Emir	34	Male	Architecture
S14	Slaveia	28	Female	Psychology
S15	Samantha	23	Female	Aerospace Engineering
S16	Alexandra	35	Female	Epidemiology

5.3.3 Procedure

Once participants agreed to take part they were presented with a broad outline of the potential topics to be covered in the interview. All interviews were conducted online via Zoom or Microsoft Teams due to participants' geographic dispersion and the impact of the pandemic on data collection. It was determined that interviewing via Zoom or Microsoft Teams would be appropriate for this study, based on prior findings showing that video interviews allow respondents to open up when conducting themselves in familiar, comfortable surroundings (Gray et al., 2020). The average interview session lasted about 45 minutes with the longest lasting 90 minutes, although participants were informed that they could determine the duration and take as long as necessary. Each interview was preceded by an information sheet and consent form that confirmed that anonymity would be maintained using pseudonyms, participants' right to leave the study at any point, even after an interview, the security of stored data, and its eventual destruction. Participants were also assured that there are no right or wrong answers and that the researcher is merely interested in learning about their experiences.

Following the initial interviews, time permitted two participants to be recontacted for a follow-up conversation. These were conducted online via Zoom and served two purposes; firstly, to see if the participants wished to clarify or add to the specific points they had made in the original interview; secondly, to explore how these participants' experiences and perceptions had evolved given the emergence of ChatGPT in late 2022, which represented a significant shift in the technological landscape. These additional conversations helped ensure that the qualitative findings for all participants remained firmly anchored in reflective accounts of their technology use and which addressed current developments in technology. Interviews were conducted between July and October 2024 and recorded and transcribed using Otter.ai (2024), a cloud-based transcription service, password-protected. Otter's functionality is well documented (Skelton, 2024). Its accuracy was initially estimated at 85-90% (Blechnyden, 2020). More recent evidence puts this figure closer to 97 percent (Pfeifer et al., 2024). Transcription errors are nonetheless possible (Loubere, 2017; Lapadat, 2000). Because of this, every transcript was listened to by the researcher against the recording. Content, wording, and emphasis were all checked. Where errors were found, corrections were made manually.

5.3.4 Analytical Procedure

When conducting qualitative analysis, close attention must be paid to the context of the data (Oltmann, 2016). All interviews were subject to reflexive thematic analysis (Braun & Clarke, 2006, 2021; Braun et al., 2023). This is a dynamic process suitable for a wide variety of data, including those in which the researcher seeks to understand each participants' personal worlds and experiences (Terry et al., 2017). The method does not seek objective knowledge but aims to make sense of the data provided, in a manner akin to storytelling (Clarke & Braun, 2014). Thus, themes are treated not as discoveries inherent in the data, but as interpretive constructions developed through engagement with participants' accounts, informed by the researcher's own theoretical positioning and reflexive awareness. Braun and Clarke consider thematic analysis as an accessible, pragmatic form of research, in which analysis proceeds as an organic process which "happens at the intersection of you and your data, and your reflexivity, your subjectivity, your disciplinary and social context" (Coxon et al., 2022, p.41). Hence, the researcher brings to the analysis their own knowledge of the context in which participants are located (see Section 5.3.5).

Following transcription of interviews, the researcher familiarised themselves with the data, through thorough reading and re-reading of each transcript, creating notes and a summary of impressions from each interview. Once an overview of an interview had been obtained, data were then assigned initial codes. The analytic process was iterative and recursive, with continual movement between the data, initial coding, researcher reflections, and the development of themes. Transcriptions were subject to both descriptive coding - highlighting important aspects of participants' experiences – and linguistic coding – focusing on the context, lexicon and meaning of the language used (Bucholtz, 2000; Larkin et al., 2006; Gibbs, 2012). Finally, conceptual coding involved interpreting data in context, with similar and related codes clustered together to produce themes, leading to a deeper semantic understanding. Ideas and key words which were noted signalled the emergent themes and these were written down.

This procedure was repeated for each transcript. In the process of examining transcripts, the researcher considered them as a set, identifying common ideas which arose and the connections between them. Themes were inductively derived but informed by theoretical and empirical insights from phase one of the study. Superordinate themes were then tabulated, with quotations and participants' names (anonymised) recorded adjacent to each theme (Alase, 2017; Larkin et al., 2019).

5.3.5 Reflexivity: The Impact and Role of the Researcher

Reflexivity played an essential role in the qualitative phase of this research. In research with human participants, the researcher forms part of the social field within which interviews are conducted. Reflecting on the influence researchers have on a study has been considered a fundamental problem of the social sciences (Soedirgo & Glas, 2020). As the researcher is always embedded in the context which generates the findings and within which they are interpreted, a dynamic process of interpretation is required in which the researcher critically reflects on their position (Berger, 2015; Palaganas et al., 2017). This stance was first acknowledged in anthropology and ethnography (Kuper, 2014; Holmes, 2020) and in contemporary qualitative psychological research, is addressed under the principle of reflexivity (Lazard & McCoy, 2020). This requires the researcher to be aware of their own positioned, rational and affective perspectives to the research and how these shape the research process – both the analytic stance and interview dynamics between researcher and participants, from which the emergent meanings were co-constructed (Berger, 2015).

In line with reflexivity, my role as interviewer involves taking an 'insider perspective' as a doctoral researcher (Berger, 2015). In practical terms, participants may have viewed me as occupying a comparable position to academic staff they engage with. This is an area where the researcher's reflexivity is of added importance, and I was continually aware of the possibility of such a 'power relationship' during the interviews. I was thus mindful to put the interviewees at ease both prior and during the interviews and strove to ensure that interpretations remained grounded in the data rather than in assumed shared experience. One aspect of the research process with the potential to affect the interviewee's conduct is their awareness of being recorded. It is potentially challenging to evaluate the influence of cameras or other technological devices on students' responses. As with the presence of the researcher, it is a problem which was considered thoughtfully when evaluating the data. However, the ubiquity of contemporary technology with recording capabilities built into the software with no externally visible camera equipment, together with participants' familiarity with videoconferencing may have reduced any potential impact recording may have.

5.3.6 Study Parts One and Two: Ethical Considerations

Both study phases were approved by Glasgow University College Research Ethics Committee. University guidelines were adhered to throughout. These accord with principles of the British Educational Research Association (BERA, 2019) which stress the necessity to conduct research with considerations of respect for people, knowledge, democratic values, the quality of educational research and academic freedom. Informed consent was solicited with assurances of anonymity and confidentiality, right to withdraw at any time without explanation, and right to withdraw data. Respondents were notified that data would be securely stored, with material destroyed on the project's completion (See Appendix 1).

For all interviews, agreement was sought and obtained from participants to be recorded via videoconferencing (Zoom) with careful checking that participants were comfortable with this. From the perspectives of ease, privacy and comfort, videoconferencing arguably makes the interview more favourable to participants. For example, a respondent's personal setting when participating in an online interview can be more comfortable and convenient than attending in person. Because software can be activated on a variety of devices, participants are free to choose their location when participating (Novick, 2008; Trier-Bieniek, 2012).

When considering participants, for whom health issues could make participation problematic, research conducted remotely may be more successful than if conducted face-to-face (Oltmann, 2016). It is possible that the sample included members of marginalised groups, who may also benefit from this method. This would be the case for those who have trouble travelling, or who might otherwise be less willing or likely to attend a physical meeting (Minichiello et al., 2008). Remotely conducted interviews can be experienced as less invasive (Sturges & Hanrahan, 2004), more private (Pridemore et al., 2005), more comfortable (Mealer & Jones, 2014), less time intensive (Trier-Bieniek, 2012) and less costly (Opdenakker, 2006). Participants for online interviews can also enhance privacy and comfort by switching off video mode and participating through audio only. A potential downside is that videoconferencing may restrict a researcher's ability to assess the environment in which a participant is situated (Irani, 2019). However, the flexibility and convenience, for both researcher and participant, together with the fact that videoconferencing preserves many features available in an in-person interview, makes it a suitable means for data gathering (Gray et al., 2020).

Confidentiality and protection of information are paramount in any study utilising personal data (BERA, 2019). To protect participants' identities, pseudonyms are used throughout the thesis. Data are stored securely on a password protected encrypted drive at the University of Glasgow, and de-identified to ensure participants' privacy.

With the design and methods of each study phase presented, the following chapter presents the survey results. The nature and interpretation of these informs the conduct of the subsequent interviews.

Chapter 6: Phase 1 - Survey Results

6.1 Descriptive Statistics

Initially, information is provided about the survey respondents. Following this, basic patterns of use are described for information sources, data collection methods, type of research methodology employed, use of videoconferencing and communication software, reasons for preferring campus/online study, training, time management, health, satisfaction and problems with technology, social media use, emotional reactions to using information sources, helpfulness, difficulty of technology and satisfaction with study progress. Following presentation of descriptive information, several distinct lines of enquiry are undertaken and presented in the section on inferential statistics.

6.2 Characteristics of Respondents

In total, 310 people responded (112 males, mean age = 30.63 years, SD=7.80; 189 females, mean age=31.32 years, SD=8.75; seven identified as non-binary, mean age=26.86, SD=2.41, two provided no response on gender). The largest group of participants were British (N=145, 46.8%), followed by European (N=61, 19.7%), Asian (N=48, 15.5%), American/Caribbean (N=21, 6.8%), Middle Eastern (N=15, 4.8%), African (N=13, 4.2%) and Australasian (N=1, 0.3%) (See Fig 6.1 below).

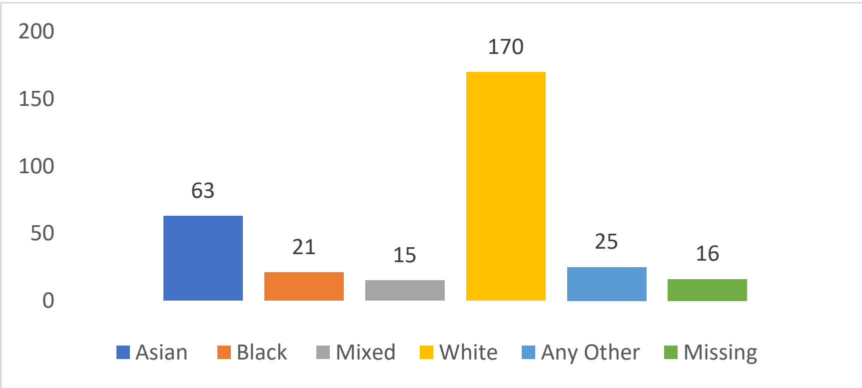


Figure 6.1 Distribution of Participants by Ethnicity

The largest ethnic group was White (N=170, 54.8%), followed by Asian (N=63, 20.3%), Other (N=25, 8.1%), Black (N=21, 6.8%), and Mixed (N=15, 4.8%). Sixteen (5.2%) provided insufficient data for coding. Most respondents were studying at UK universities

(England, N=220, 71.0%; Scotland, N=38, 12.2%; N. Ireland, N=13, 4.2%; Wales, N=7, 2.3%) with a small percentage (N=20, 6.5%) outside the UK. Twelve provided no information.

A majority of participants recruited were from science disciplines (N=215, 69.4%) with the remainder from non-science disciplines (N=88, 28.4%). Seven provided no data. Of those responding, most were full-time students (N=274, 88.4%, mean age=29.46, SD=5.99), with a small number who were part-time (N=31, 10.0%, mean age=43.71, SD=13.34). Those studying part-time were significantly older (t (302) =10.64, $p<.001$).

Although a higher proportion of those studying part-time (66.7%) rather than full-time (62.2%) were females, these proportions did not significantly differ (Fisher's Exact p=.69; N=297). There was, however, a significant association between gender and study discipline. A higher proportion of non-science students were female compared to science students (74.4% v 57.6%; N=296, Fisher's Exact p=.008).

Ethnic minority students comprised a significantly lower percentage of part-time students (N=7, 22.6%) compared to full-time (N=116, 44.8%; Fisher's Exact p=.021). Full time students were more likely to be studying science (N=220, 73.5%) than non-science subjects (N=79, 26.5%; Fisher's Exact p=.019), whilst those studying part-time were divided approximately equally between sciences (51.60%) and non-sciences (48.4%). Independent t-tests showed that science students were significantly younger (29.13 cf. 35.57 years; t (300) =-6.44, $p<.001$) and had been studying for longer (2.97 cf. 2.66 years; t (300) =1.85, $p=.06$). No difference in hours spent on computing devices on a typical day was found by gender; t (291) =.39, $p=.70$), ethnicity ($F_{4,283}=.44$, $p=.78$), country of study ($F_{4,287}=.63$, $p=.65$) or study discipline (7.86 cf. 8.30; t (300) =-1.03, $p=.30$). The time respondents had been studying at postgraduate level is presented in Fig 6.2 below.

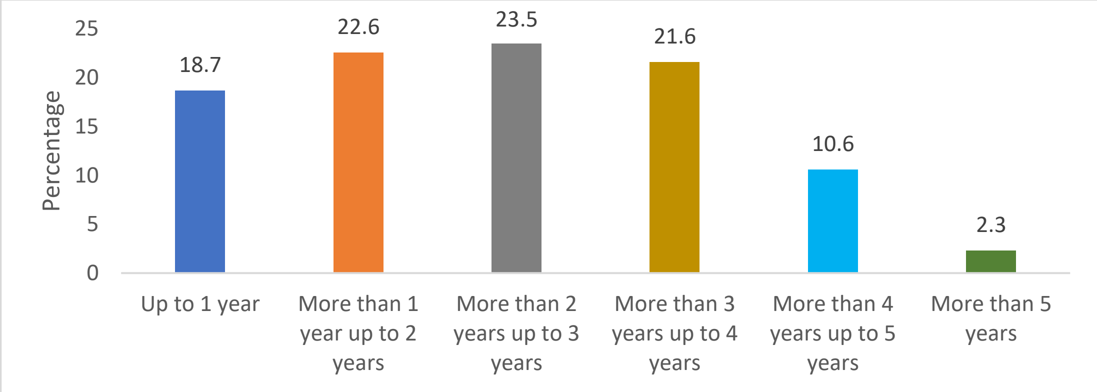


Figure 6.2 Percentage Distribution of Length of Time Studying

With the composition of the sample described, the next section presents descriptive patterns of students' digital technology use.

6.3 Information Sources and Data Collection

In this section the digital information sources used by doctoral students to research and gather data are presented, with relevant group comparisons given. These provide basic information regarding how research conduct is shaped by digital resources. This has direct relevance to Research Question 1: How do doctoral students employ digital technologies to research literature and collect data?

When asked whether they preferred physical rather than digital copies of material to read, participant opinion was divided. There were 114 (36.8%) who agreed/strongly agreed compared to 107 (34.5%) who disagreed/strongly disagreed. Just over one-quarter were undecided (N=87, 28.1%). These preferences aside, the vast majority (N=295, 95.2%) reported using online sources to access articles and books. *Google Scholar* was the most popular option for accessing information (N=267, 86.1%), followed by University Library databases (N=224, 72.3%) and subject-specific databases (N=139, 44.8%).

Substantial numbers of respondents reported using websites (N=137, 44.2%), and video-conferencing software (N=134, 43.2%) for recording/data collection. The benefits of doing so and the frequency with which they were endorsed are shown in Fig 6.3.

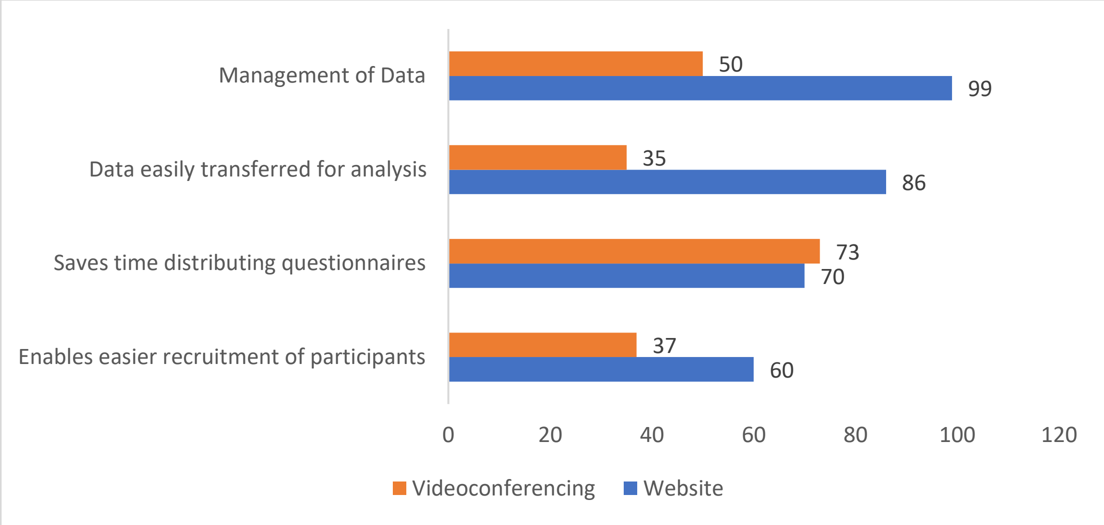


Figure 6.3 Advantages of Data Collection by Videoconferencing and Websites

The most popular perceived benefits amongst those using websites, were helping to manage data (N=99, 31.9%) and ease of transferring data for analysis (N=86, 31.5%). Amongst those using videoconferencing for data collection, the benefit most often reported was saving time distributing questionnaires (N=73, 23.5%). Overall, greater benefit was perceived in data collection through a website.

No association was found between use of videoconferencing for data collection and years of study (χ^2 (5) =7.99, N=308, p=.16). However, use of a website for data collection was associated with study time (χ^2 (5) =10.67, N=308, p=.058). As can be seen below (Fig 6.4), after the first two years of study the proportion of respondents reporting using technology for data collection declined steadily. Given that the majority of respondent were full-time, this may be explained on the basis that full-time students tend to collect data in the first two years, whilst part-time students will tend to collect data later.

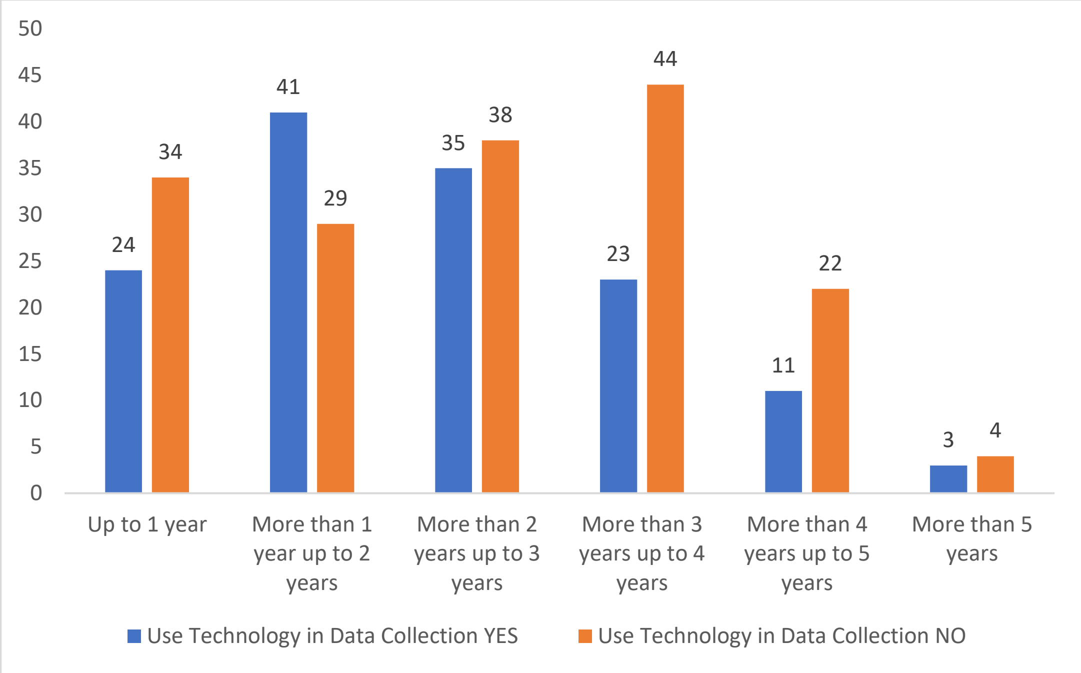


Figure 6.4 Relationship between Use of Technology in Data Collection and Length of Time Studying

6.4 Research Methodology and Presentation

Participants reported using a variety of research methodologies. Mixed methods was most prevalent (N=180, 58.1%), followed by quantitative (N=145, 46.8%), literature based (N=125, 40.3%) and qualitative methods (N=79, 25.5%). When asked whether they used technology regularly in their studies, all but four agreed/strongly agreed (N=302, 97.4%). Answers to this were not associated with gender (Fisher's Exact p=.22), ethnicity (Fisher's Exact p=.08), country of study (Fisher's Exact p=.10) or study discipline (science v non-science; Fisher's Exact p=.12). The most preferred platform for quantitative analysis was *Excel* (N=231, 74.5%; Fig 6.5). After this, *R* (N=96, 31.0%) and *SPSS* (N=86, 27.7%) were the most popular.

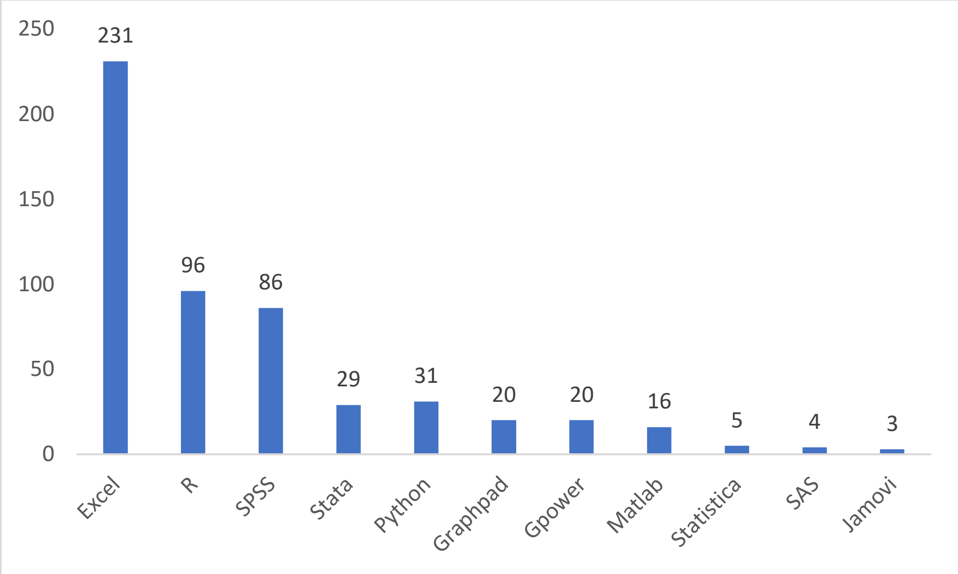


Figure 6.5 Programs Used for Quantitative Analysis

For qualitative methods, *NVivo* (N=75, 24.2%) amongst the available options, this platform was the most frequently reported, followed by *Qualtrics* (N=28, 9.0%). For presentation software, the overwhelming choice was *PowerPoint* (N=289, 93.2%), with *Google Slides* a distant second (N=41, 13.2%).

6.5 Videoconferencing

Videoconferencing tools have become central to doctoral study, enabling communication with others for supervision, collaboration, and peer interaction. This section details how frequently doctoral students use them.

Most respondents (N=303, 97.7%) reported using videoconferencing to communicate with lecturers or supervisors, whether rarely (N=25, 8.1%), occasionally (N=86, 27.7%) or frequently (N=192, 61.9%). Similarly, most (N=281, 90.7%) reported using it to communicate with other students, whether rarely (N=59, 19.0%), occasionally (N=106, 34.2%) or frequently (N=116, 37.4%). Videoconferencing was more likely to be frequently used with supervisors (N=192, 61.9%) than with other students (N=116, 37.4%; Fisher's Exact $p<.00001$). The most popular platforms were *Zoom* (N=267, 86.1%) and *Teams* (N=257, 82.9%) with *Google Meet* (N=56, 18.1%) and *Skype* (N=43, 13.9%) used by a minority.

6.6 Communication Software/Messaging

This section presents findings on how messaging and communication software were employed for peer communication, informal support, and collaboration. The extent of face-to-face and technologically mediated communication is also reported.

A large majority (N=287, 92.6%) reported using instant messaging for communicating with other students; few (N=21, 6.8%) reported having never used it. A clear preference for *WhatsApp* was expressed, by four in every five respondents (N=252, 81.6%). It was selected as the most frequently used platform for messaging by 70.6% (N=219) of participants. Most (N=241, 77.8%) reported spending less than one hour/day using instant messaging (less than 30 minutes, N=119, 38.4%; between 30 minutes and one hour, N=122, 39.4%). Participants reported that receipt of information was evenly split between being face-to-face/in person (N=156, 50.3%) and technologically mediated (N=154, 49.7%).

6.7 Campus Based Study Motivations

Despite flexibility offered by digital technologies, many expressed a wish for campus-based study. Almost three-quarters (N=228, 73.5%) preferred a campus-based programme to an online one (N=77, 24.8%). This preference was not associated with gender (N=297, Fisher's Exact p=.17), ethnicity (N=290, Fisher's Exact p=.78) or country of study (N=294, Fisher's Exact p=.42). The reasons why campus-based study was desired, outlined below, primarily relate to benefits afforded through face-to-face communication, social communication and physical access to facilities.

Just over half who preferred campus-based study (N=133, 58.3%) expressed their preference based on opportunities they believed campus-based study offered for social interaction, building relationships and communication, with this seen as aiding support and learning. The second most popular reason was the necessity of a campus-based education for conducting certain kinds of study, such as lab-based work, with the campus providing a more conducive learning environment (N=39, 17.1%). Fifteen respondents (6.6%) expressed their preference for campus-based education on the grounds that online learning could create difficulties such as distraction or social isolation. In all, 18 individuals expressed a preference for a blended approach utilising online and campus-based education. Of these 18, the majority (N=15) opted for a campus-based education.

6.8 Online Study Motivations

As indicated, almost a quarter of respondents (N=77) expressed preference for online study. The most popular reason for this choice concerned aspects of flexibility (N=52, 67.5%), with the opportunity to work from home, reduce travel, save time, and study in another country, all cited. After this came desire to prioritise one's health, whether physical (reduce threat of COVID-19 infection) or mental (e.g., anxiety reduction) (N=6, 7.8%), followed by working to one's own schedule and not an externally imposed one (N=4, 5.2%).

6.9 Training

Appropriate training can be considered necessary for doctoral students to work effectively with digital technologies. This section provides information on the type of training received and whether it was judged to be helpful. A majority (N=246, 79.4%) reported receiving some form of training. This was unrelated to gender (N=300, Fisher's Exact p=.77), ethnicity (N=293, Fisher's Exact p=1.00) or country of study (N=297, Fisher's Exact p=.56). Science students, however, were less likely to have received training than non-science students (77.1% cf. 89.8%; Fisher's Exact p=.01). The most popular training areas were quantitative analysis (N=181, 58.2%) and literature searching (N=161, 51.9%). Few reported receiving training for videoconferencing (N=43, 13.9%) with this the most striking gap in provision. Figure 6.6 below details the numbers of respondent receiving training across different areas and the numbers who agreed or strongly agreed that it was helpful. As can be seen, most respondents who reported receiving training (in any area) found it helpful.

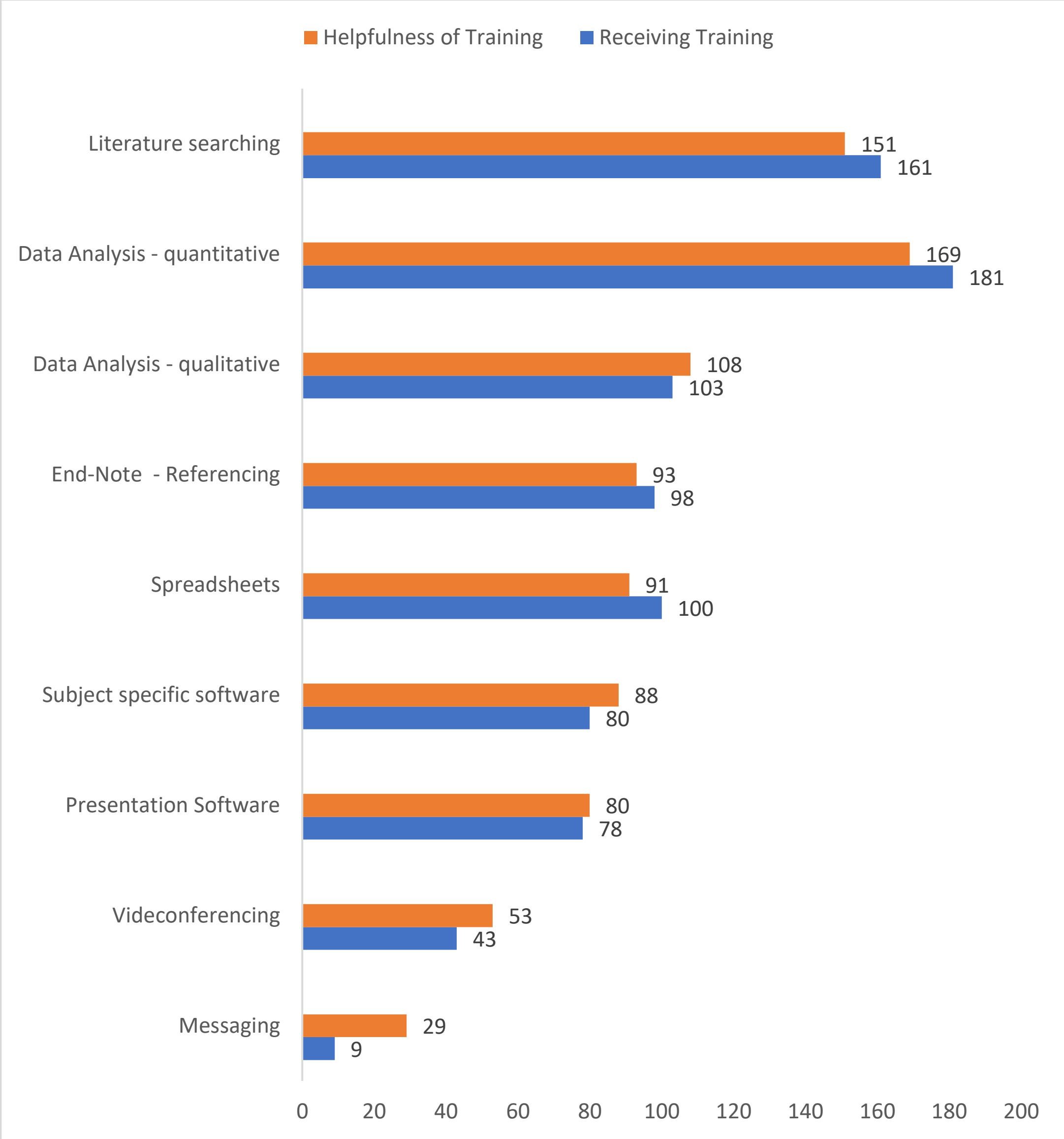


Figure 6.6 Numbers Receiving Training in Specific Areas and Helpfulness of Training

In some areas more respondents reported the training as helpful than reported receiving it, suggesting they may have been referring to self-training.

6.10 Time Management and Health and Well-Being

Time management has been linked to academic performance and is an important element of doctoral study. This section presents data on students' views about how digital time management impacts upon their health and well-being. Despite over half the sample indicating they were happy (agree/strongly agree) with how they manage their time (N=166, 52.9%) (Fig 6.7), a large majority (N=242, 78.1%) nevertheless reported spending more time on the Internet than intended, and that spending time online affected how much exercise they take (N=195, 62.9%) (Fig 6.8).

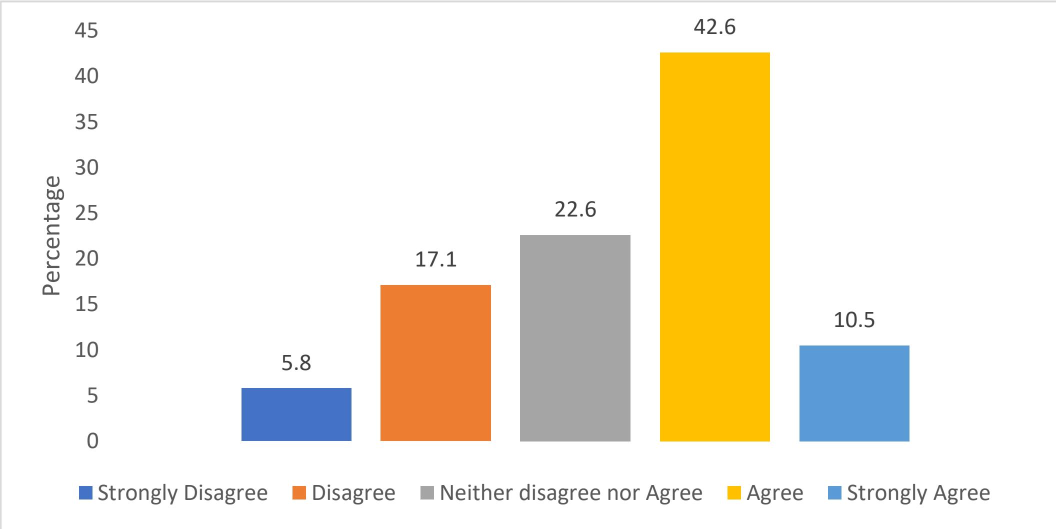


Figure 6.7 Happiness with Time Management

Just under half reported time online interfered with sleep (N=153, 49.4%) with similar numbers reporting it affected their social life (N=148, 47.7%) (Fig 6.8 below).

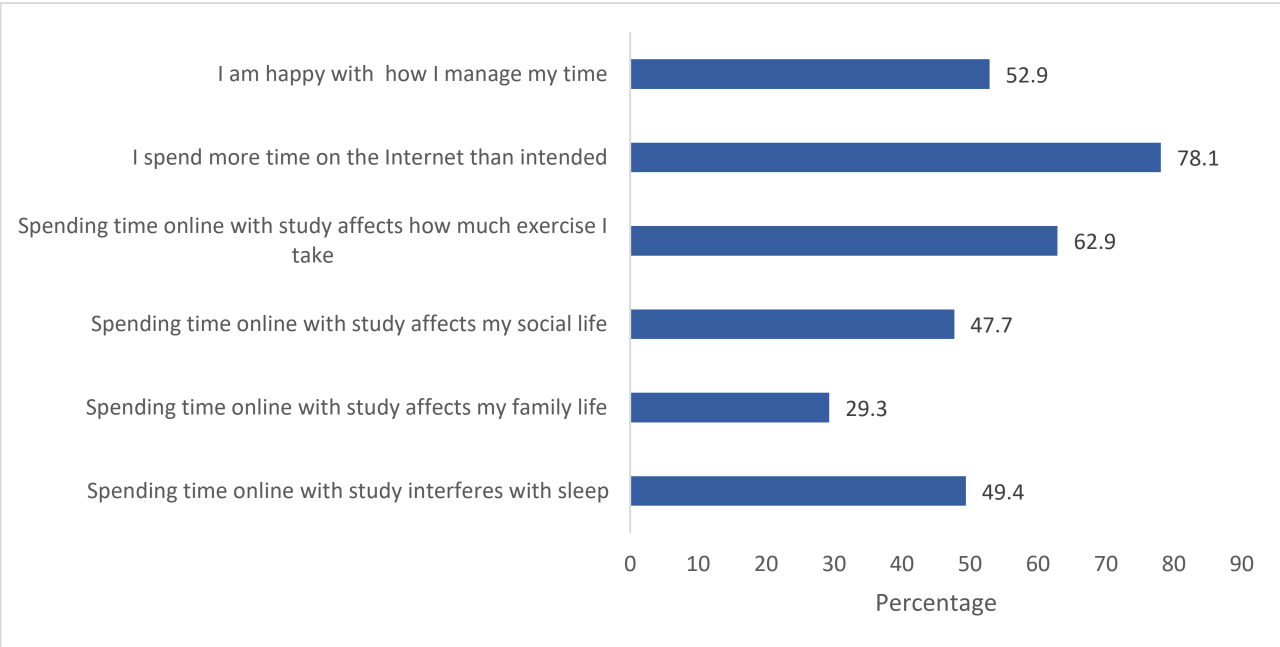


Figure 6.8 Percentage Endorsing Different Statements about Time Management

These data then suggest time management, technology use, and well-being are not independent. Current self-reported health is illustrated in Fig 6.9.

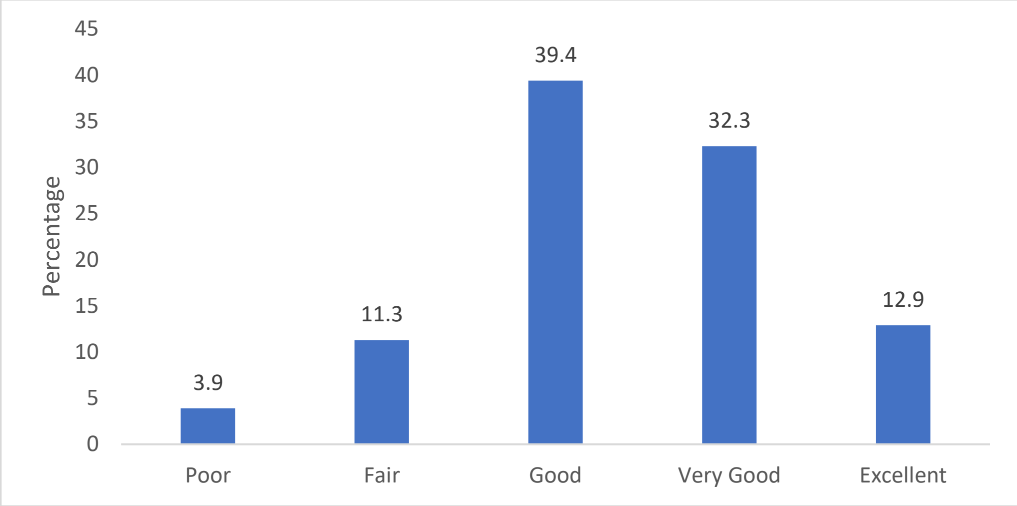


Figure 6.9 Self-Reported Current Health

Over 80% (N=262, 84.8%) reported being in good/very good/excellent health. However, over one in five (N=71, 22.9%) reported their health was worse than one year ago (Fig 6.10).

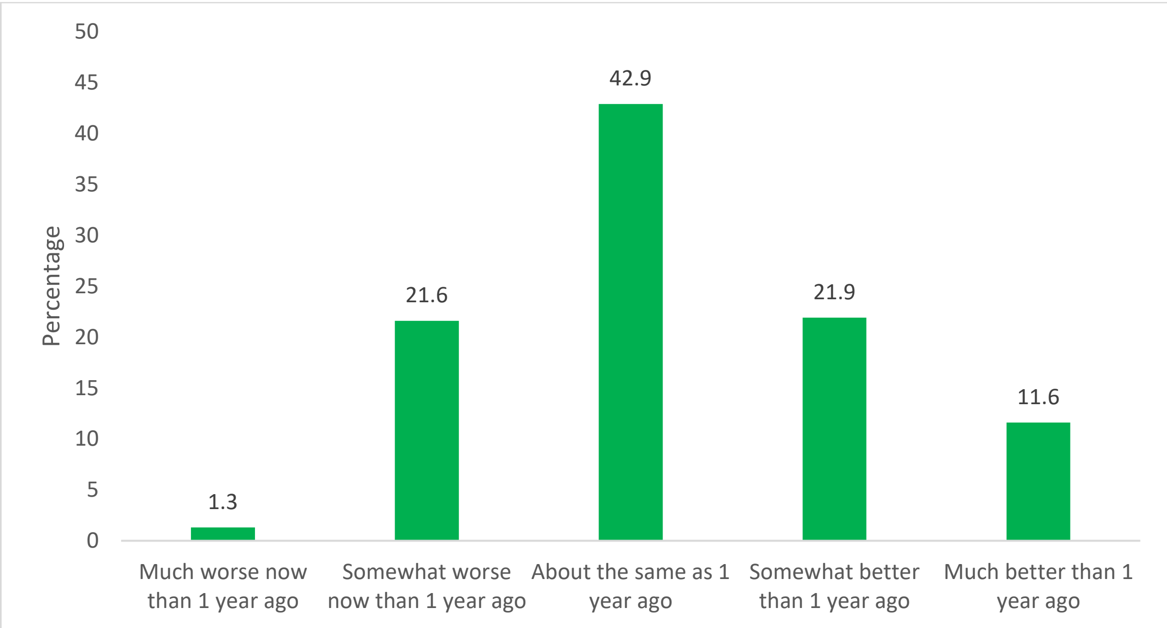


Figure 6.10 Self-Reported Health Compared to One Year Ago

Unsurprisingly, over half (N=174, 56.12%) reported the pandemic had adversely affected their study, with a small proportion (N=52, 16.7%) pointing to a positive effect (Fig 6.11).

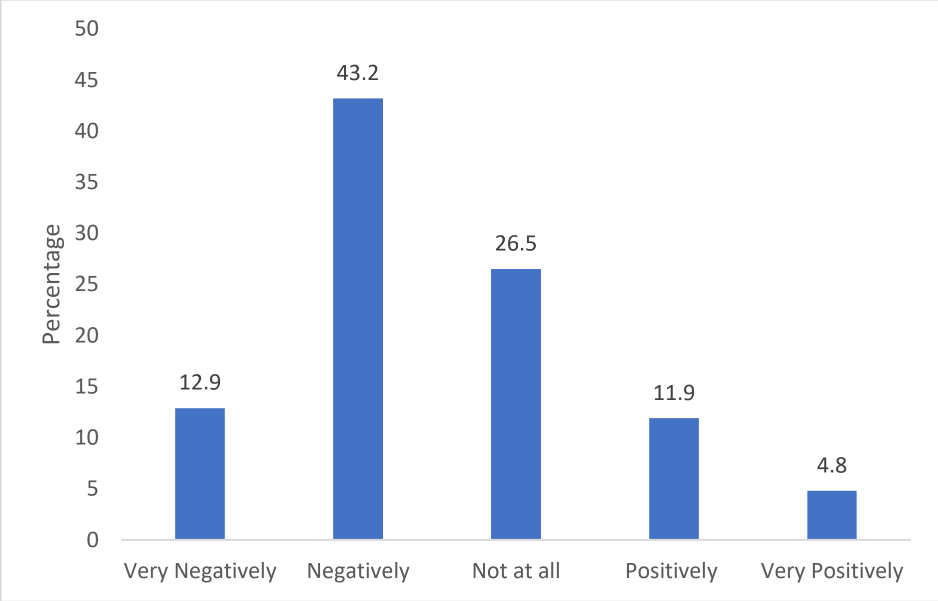


Figure 6.11 How the Covid-Pandemic has Affected My Studies.

Self-ratings of health compared to the previous year were significantly associated with the period of data collection (Time1/Time2); ($\chi^2(4, 308) = 10.43$, p=.034). A higher proportion of those responding in the period when COVID restrictions were in place reported feeling worse than those who responded in the subsequent period (38.3% cf. 29.2%). Similarly, a higher percentage reported feeling better in the latter period than during COVID (27.3% cf. 18.8%).

A majority (N=214, 69.0%) reported experiencing some difficulty in paying bills (Fig 6.12).

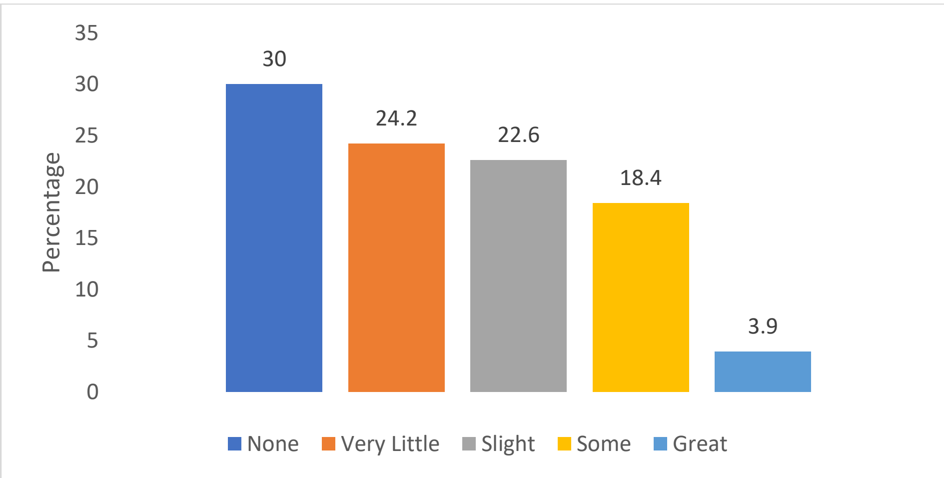


Figure 6.12 Percentage Reporting Different Levels of Difficulty in Paying Bills

Difficulty paying bills was unrelated to gender ($\chi^2(4)$ =1.57, N=299, p=.81), country of study ($\chi^2(4)$ =2.31, N=296, p=.68) and study discipline ($\chi^2(4)$ =1.06, N=301, p=.90), though it was associated with ethnicity ($\chi^2(4)$ =12.89, N=292, p=.012); a higher proportion of ethnic minority students (78.9%) reporting at least some difficulty compared to White students (63.3%).

6.11 Satisfaction and Problems using Technology

This section has direct bearing on Research Question 2 and describes areas of satisfaction which doctoral students report from working with digital technologies, as well as the kinds of problems they experience. The findings in this section highlight the conflicting nature of technology use for doctoral students.

6.11.1 Satisfaction

Overall, 265 respondents (85.5%) responded to this question. Analysis of participants' open-ended responses yielded several themes (Fig 6.13); the most frequently cited of these referenced *access/speed of access to information or news in a global space* (N=101, 32.3%), followed by technology *aiding academic research and work* (N=46, 14.8%). Other themes were *communicating/collaborating and keeping in touch with others* (N=39, 12.6%), *life being made easier/more convenient/ flexible* (N=29, 9.4%), and *ease of use for organising data and time management* (N=22, 7.1%). Twelve (3.9%) referred to *ability to access art, entertainment, or social media,* while seven (2.3%) referred to a sense of accomplishment. For crosstabulations with demographic variables, expected frequencies were too small to permit meaningful analysis.

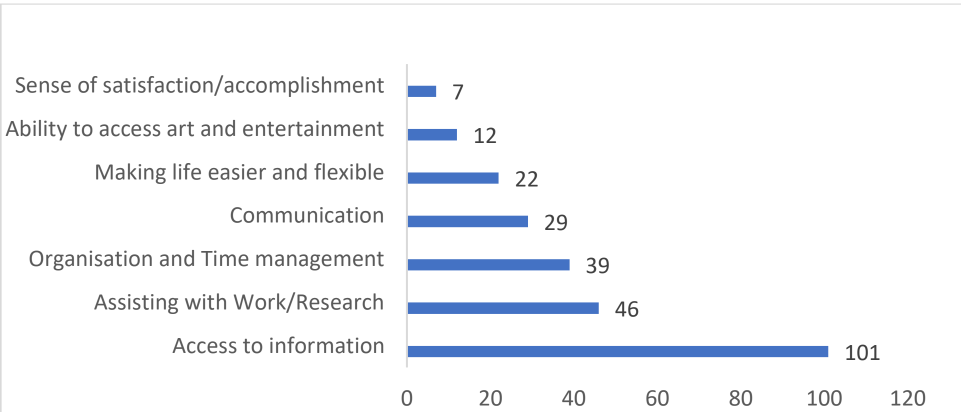


Figure 6.13 Reasons for Satisfaction with Technology

6.11.2 Problems

For this open-ended question, 260 participants responded (83.9%). Five main problems were raised by participants in the open-ended responses; the most frequently cited was *distraction and information overload* (N=61, 19.7%), followed by problems with *technical issues* such as difficulty using software, or loss of connection (N=60, 19.4%). After these issues, *time management* was most often cited (N=49, 15.8%), then *physical problems* associated with internet use such as eye strain and back pain (N=31, 10%) and problems with *addiction* (N=21, 6.8%). Issues connected with *preference for human contact* and *disruption to work-life balance* were noted by eleven (3.5%). Few commented on *data protection and privacy* (N=4, 1.3%) or *risk of misinformation* (N=2, 0.6%). Eight (2.6%) stated they experienced no problems. Expected frequencies for these categorised responses were again too small to permit meaningful analysis for cross tabulation with demographic variables.

In reply to a different question, 12.5% (N=39) agreed/strongly agreed that they had concerns about privacy and security issues. This was unrelated to gender (χ^2 (4) =5.94, N=290, p=.20), country of study (χ^2 (4) =5.40, N=287, p=.25) and study discipline (χ^2 (4) =1.27, N=292, p=.87), though was associated with ethnicity (χ^2 (4) =9.15, N=283, p=.006). White students were more likely than ethnic minority respondents to agree/strongly agree they had security concerns (17.6% v 6.7%).

6.12 Range of Social Media Use

The most popular social media platforms were LinkedIn (N=247, 79.7%), YouTube (N=232, 74.8%), Facebook (N=218, 70.3%), Instagram (N=205, 66.1%) and Twitter (N=196, 63.2%), The distribution of the number of social media outlets used is shown in Fig 6.14.

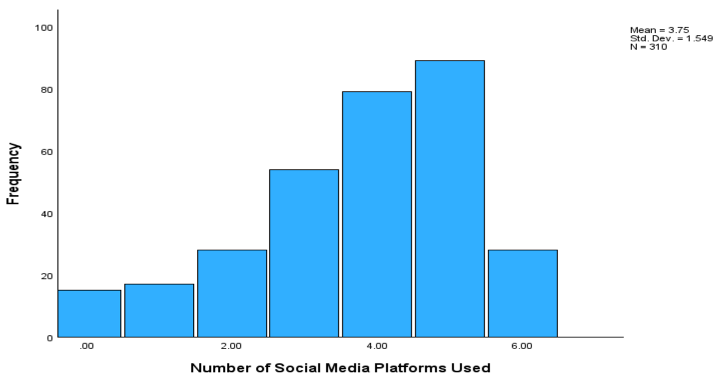


Figure 6.14 Number of Social Media Outlets Used

6.13 Emotional Responses to using Electronic Information Sources

This section details the prevalence of doctoral students' emotional reactions when engaging with electronic information resources (e.g., online databases, search engines, digital libraries). These have potential importance in influencing motivation, confidence, and persistence in study. Positive emotions were more frequently reported than negative ones. The most widely reported was feeling interested (N=252, 81.9%), followed by engaged (N=221, 71.3%) and relaxed (N=154, 49.7%). More negative emotions: feeling bored (N=52, 16.8%), frustrated (N=41, 13.2%) and anxious (N=39, 12.6%) were reported by fewer than one-in-five (Fig 6.15).

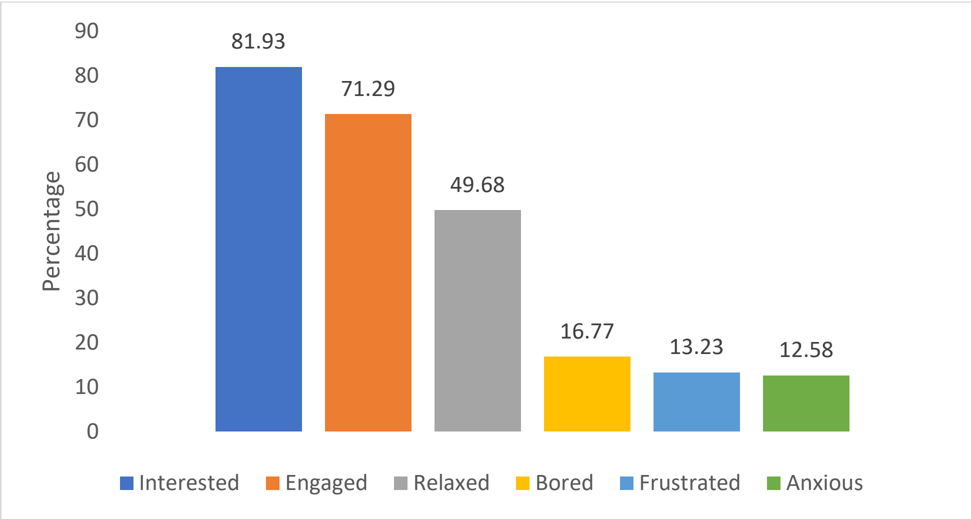


Figure 6.15 Emotional Responses to Using Electronic Information Sources (Percentages)

The distribution of scores summed from the three negative emotional responses (boredom, frustration, and anxiety) is shown in Fig 6.16.

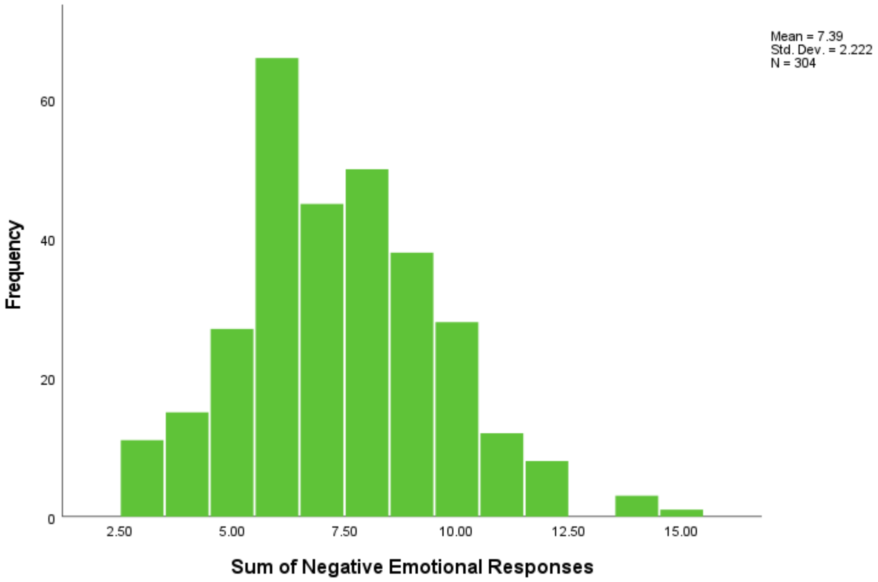


Figure 6.16 Frequency Distribution of Summed Negative Emotional Responses to Using Electronic Information Sources.

Similarly, distribution of scores summed from the three positive emotional responses (interest, engagement, and relaxation) is shown below (Fig 6.17).

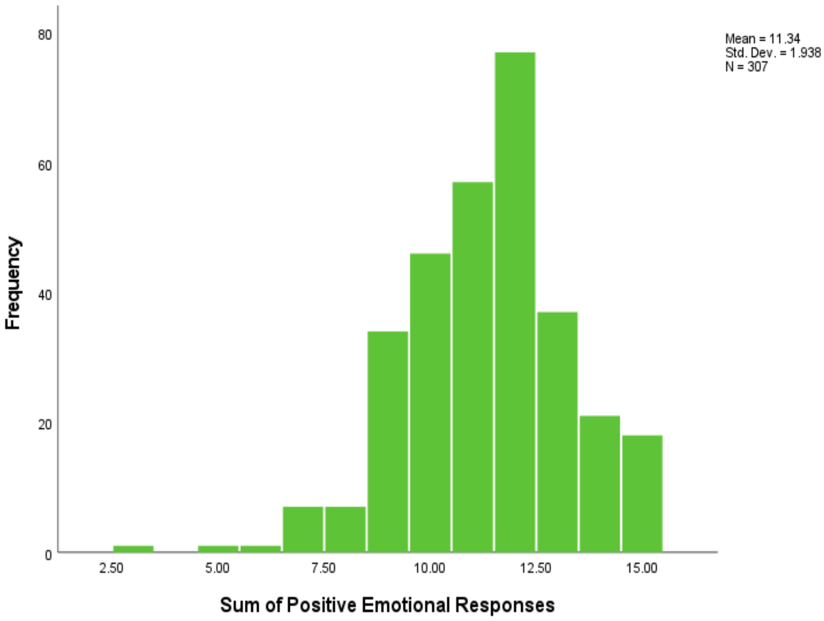


Figure 6.17 Frequency distribution of summed Positive Emotional Responses to using Electronic Information Sources.

6.14 Helpfulness and Difficulty of Technology

This section gives respondents' overall impression of the helpfulness of digital technologies in supporting their study and the extent to which they experience difficulties in using them. These provide useful information about the double-edged role of technology in doctoral study. Respondents judged the most helpful software to be videoconferencing (99.6%), presentations (95.7%), quantitative analysis (94.6%), and email (93.8%). Although endorsed by 61.5% of respondents, software for recording lessons was seen as the least helpful in terms of the proportion using it (Fig 6.18).

A minority (N=38, 12.3%) reported finding software applications difficult to use. This was not related to gender (Fisher's Exact p=1.0), ethnicity (Fisher's Exact p=0.29), country of study (Fisher's Exact p=0.30) or study discipline (Fisher's Exact p=0.25). Further analysis is reported later in the thesis.

Additional questions on computing equipment used revealed that participants were most satisfied with a home laptop (77.8%) and mobile phone (76.7%) and least satisfied with a university desktop (59.4%) and university laptop (53.8%) (Fig 6.19).

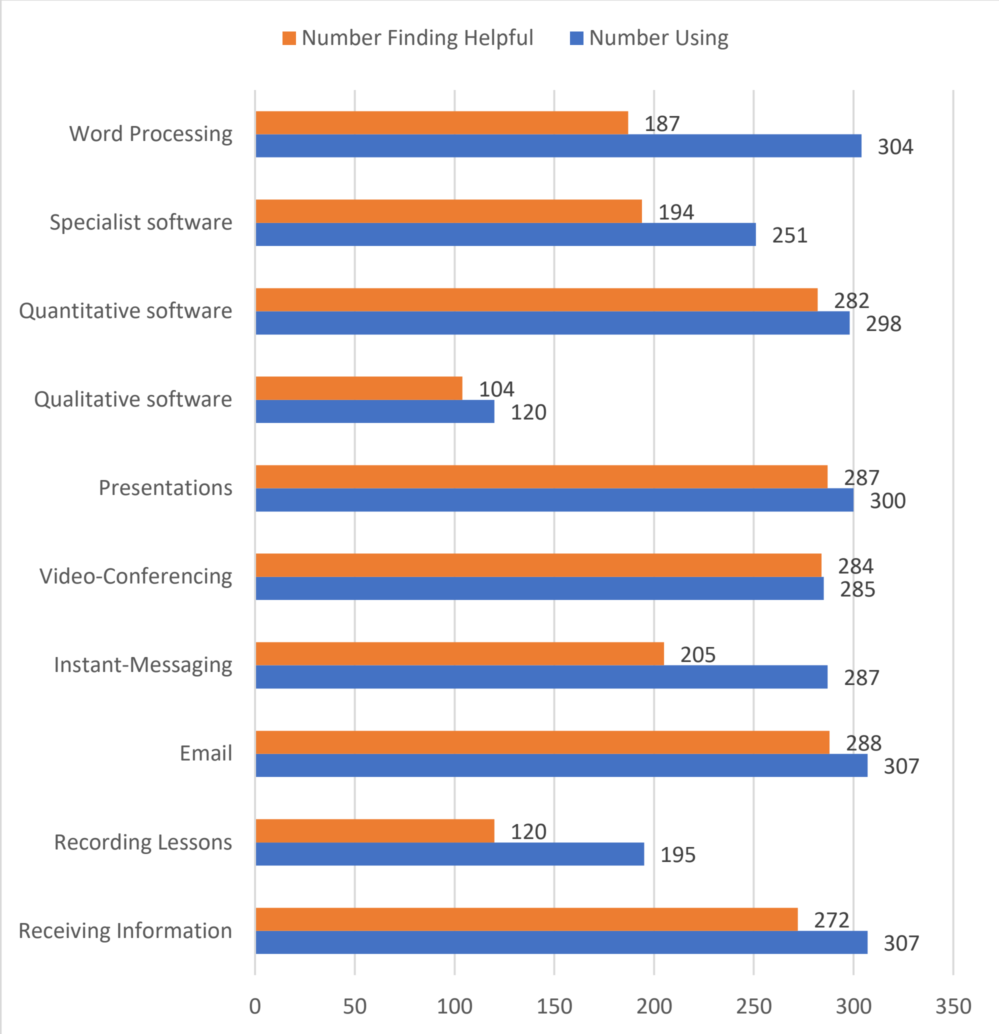


Figure 6.18 Reported Helpfulness of Different Types of Software (N=310)

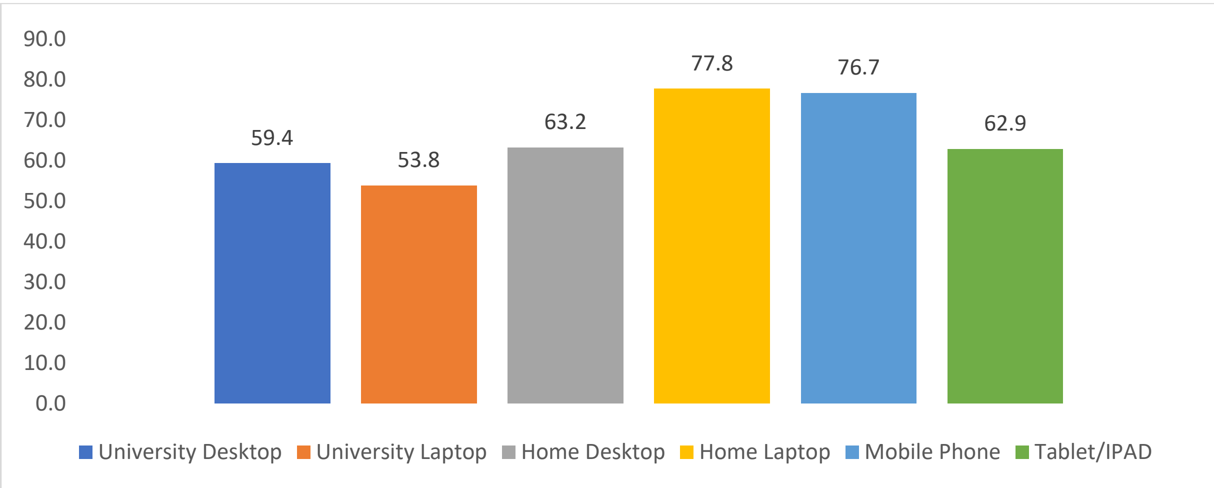


Figure 6.19 Percentage Satisfaction with Computing Devices Used

6.15 Backing up Data

Backing up data is a critical aspect of research. Protecting data plays a key role in research continuity. This section outlines how students have backed up data, and the frequency with which they have done so.

Approximately one in six reported backing up data several times a day (N=54, 17.4%), with a similar number doing so less than once a month (N=51, 16.5%). A hard drive was most frequently chosen for this (N=152, 49.0%), followed by Google Drive (N=138, 44.5%), cloud storage (N=137, 44.2%) and a USB/flash drive (N=129, 41.6%).

6.16 Satisfaction with Study Progress

Students' level of satisfaction with their study progress provides a key measure of academic progress. This may be dependent on many factors – including their experiences with technology. The determinants of this will be assessed following the summary of descriptive results below. As figure 6.21 show, a large majority (N=224, 73.0%) were satisfied with the progress of their studies, though a sizeable minority (N=42, 13.7%) were not.

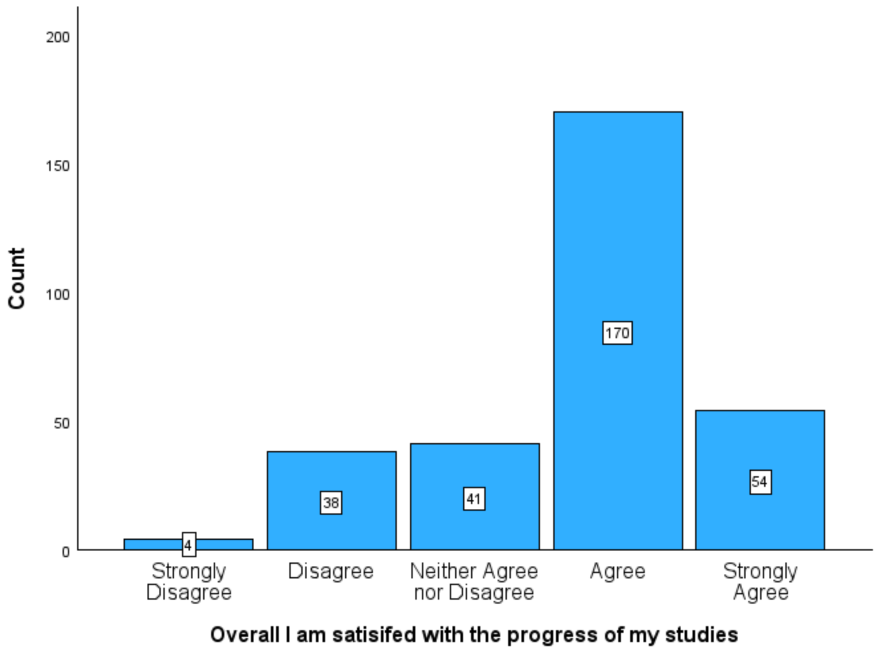


Figure 6.20 Reported Satisfaction with Study Progress

6.17 Descriptive Statistics: Summary

This section summarises the most important descriptive findings of the survey. The data, drawn from a diverse sample of doctoral students, suggest several key points. Firstly, that students are considerably reliant on technology – for communications with staff and students, time management, accessing information, and collecting, managing, and analysing research data.

A range of benefits to studying in this technology-based environment were advanced. However, there appear to be limits on students' desire to work within a completely digital environment. Opinion was divided regarding preferences for electronic or physical copies of books and articles, with further differences concerning the relative advantages/disadvantages of virtual, compared to face-to-face communication, an issue which came to prominence during the pandemic. Closely related to this, clear differences were observed in the perceived advantages and disadvantages of studying in online and campus environments.

The reported sources of satisfaction and problems experienced suggest rapid access to large amounts of data is both satisfying and a cause of distraction and information overload, a problem recognised in the literature (Benselin & Ragsdell, 2016; Al-Kumaim et al., 2021; JISC, 2024). Similarly, benefits of using technology to aid time management were mirrored by technology use precipitating problems with time management, such as distraction and addiction. In this context, a majority reported time online interfered with sleep quality, exercise and social and family life.

Reliance on technology came with preferred use of a restricted range of software tools; for word processing (Word), quantitative analysis (Excel), qualitative analysis (NVIVO), presentations (PowerPoint) and videoconferencing (Zoom and Teams), the clear expressed preferences reflect the market dominance of a small number of technology companies across the higher education landscape.

In this technology-mediated eco-system, a distinct minority reported finding software applications difficult to use. This has implications for students' well-being and study progress. A related concern is that a significant minority reported receiving no training in software use, even as participants were becoming increasingly reliant on technology. Those who find software difficult to use and lack prior training must be considered doubly disadvantaged compared to other students. Given the rapid rise of videoconferencing with the pandemic, lack of training in its use is unsurprising. Although many successfully used it, problems have been reported, including the propensity for distraction by environmental stimuli (Lee et al., 2022). Although its utility is now unquestioned, optimal exploitation of videoconferencing requires familiarity with its basic functionality and ease in using it to communicate with other scholars. Of the different kinds of internet activity participants engaged in, work-related online activity was reported by a majority as taking up the most time. Nevertheless, a substantial number reported spending more time on social media than being engaged in other activities, including work. Overall, few demographic differences were evident in reported use.

In conclusion, several themes may be extracted from the analysis so far. These concern the conflicting - enabling and disabling - roles of technology, the emotional dimension to working with technology and the considerable variability in the use and appraisal of technology.

Several issues arising from the nature of the data presented above are explored in the statistical analyses which follow. These are:

1. Which factors predict satisfaction with study progress?
2. Is helpfulness in one area of technology related to the perceived helpfulness in others?
3. What predicts emotional reactions to accessing electronic information sources?
4. What predicts difficulty in using/learning software applications?
5. How is technology use and time management (and other factors) related to respondents' health and well-being?
6. How is communication with others related to well-being and study progress?

6.18 Inferential Statistics

This section presents results of the inferential statistical analyses conducted to investigate relationships between doctoral students' use of digital technologies, emotional reactions, well-being, time management and perceived study progress. This has direct bearing on Research Question 3, which addresses whether there are identifiable patterns of technology use that differentiate those who feel productive from those who do not. In the section below, the rationale is also provided for the parametric forms of analyses which have been utilised.

6.19 Study Progress

Several issues were specifically examined in relation to satisfaction with study progress. These were (A) time management, (B) time spent studying and using technology, (C) social media use, (D) helpfulness of technology, (E) preferences for accessing information in digital/physical form, (F) finding software difficult to use, (G) training, (H) emotions felt when using information sources, (I) stress, health and well-being, (J) communication with students and lecturers and (K) demographic factors (e.g., gender, ethnicity, age, country of study, field of study, nationality).

Satisfaction with study progress was not normally distributed (Shapiro-Wilk, $W=.82$, $df=307$, $p<.001$), with excessive skewness (-5.91), though kurtosis was acceptable (0.96) (Field, 2018). This lack of normality likely results from both the sample size and that the Likert scale used to measure study progress (Field, 2018). As indicated earlier (Borgatta & Bohrnstedt, 1980; Sullivan & Artino, 2013; Harpe, 2015) Likert scales may be treated as 'imperfect interval scales' and produce unbiased answers, despite violations of normality (Norman, 2010; Field, 2018). Schmidt & Finan (2018) have also demonstrated that regression is robust to potential violations of normality, once sample sizes exceed 25.

6.19.1 Time Management

Happiness with time management was significantly negatively correlated with spending more time on the Internet than intended ($r(301)=-.36$, $p<.001$), and with spending time online affects my social life ($r(304)=-.30$, $p<.001$), interferes with sleep quality ($r(305)=-.37$, $p<.001$), affects family life ($r(302)=-.26$, $p<.001$), affects how much exercise I take ($r(303)=-.25$, $p<.001$) and with the sum of problems caused by spending time online ($r(299)=-.38$, $p<.001$).

Satisfaction with study progress was significantly positively correlated with happiness with time management ($r(303)=.38$, $p<.001$) and significantly negatively correlated with; spending more time on the Internet than intended ($r(301)=-.19$, $p<.001$), spending time online interferes with my social life ($r(304)=-.13$, $p=.02$), spending time online affects my family life ($r(302)=-.15$, $p=.009$) and the sum of problems caused by spending time online ($r(299)=-.14$, $p=.013$).

6.19.2 Time Spent Studying and Using Technology

Hours on a typical day spent using Mobile Phone/Laptop/Desktop/or Tablet was significantly correlated with time spent using email ($r(298)=.19$, $p<.001$) and with satisfaction with study progress ($r(298)=.17$, $p=.004$). The latter was not related to time spent using email ($r(305)=.06$, $p=.30$), nor to the length of time studying ($F_{5,300}=.66$, $p=.66$).

6.19.3 Social Media Use

Satisfaction with study progress was unrelated to the number of social media platforms used ($r(307)=.04$, $p=.52$) and use of Twitter, YouTube, LinkedIn, Facebook, SnapChat and Instagram ($p>.05$ in all cases).

6.19.4 Helpfulness of Technologies

As stated, most respondents (>50%) reported finding each specific technology helpful. Satisfaction with study progress was significantly positively correlated with helpfulness of software for quantitative analysis ($r(298)=.15$, $p=.008$), videoconferencing ($r(305)=.20$, $p<.001$), technology used for receiving information ($r(288)=.14$, $p=.021$), using email in studies ($r(304)=.14$, $p=.017$), online data collection ($r(251)=.13$, $p=.048$) and how satisfied respondents were with a) their desktop computer at home ($r(67)=.37$, $p=.002$) and b) with the university supplied laptop ($r(77)=.32$, $p=.005$).

6.19.5 Preferences for Physical or Digital Copies of Articles/Books Accessed

Preference for digital over physical copies of articles/books when reading was significantly correlated with satisfaction with study progress ($r(306)=.17$, $p=.003$).

6.19.6 I Find Software Difficult to Use

Finding software applications difficult to use was significantly correlated with lower satisfaction with study progress ($r(300)=-.20$, $p<.001$).

6.19.7 Training

Whether respondents had ever received training in technology use was unrelated to satisfaction with study progress (r (306) =-.08, p=.17).

6.19.8 Emotions Felt When Using Information Sources

Satisfaction with study progress was related to emotions felt when using information sources. There were significant negative correlations with feeling frustrated (r (305) =-.17, p=.003), bored (r (307) =-.16, p=.005) and anxious (r (304) =-.24, p<.001) and positive correlations with feeling interested (r (307) =.13, p=.02), engaged (r (305) =.16, p=.005) and relaxed (r (307) =.19, p<.001). Overall positive emotions when using information sources were significantly positively correlated with study progress (r (305) =.22, p<.001), whilst overall negative emotions were significantly negatively correlated with it (r (302) =-.26, p<.001).

6.19.9 Stress, Health and Well-Being

Satisfaction with study progress was significantly correlated with the pandemic affecting studies positively (r (306) =0.26, p<.001), current general health (r (307) =0.25, p<.001), health compared to one year ago (r (306) =.14, p=0.017), and perceived stress (r (306) =-.28, p<.001).

6.19.10 Communication with Other Students and Lecturers

Communicating with lecturers through videoconferencing (r (302) =.06, p=.25) and instant messaging (r (305) =.07, p=.88) were not related to study progress. However, using videoconferencing to communicate with other students was correlated with study progress (r (305) =.24, p<.001), while use of instant messaging was not (r (300) =.01, p=.88). Whether students received information face-to-face (3.83) or by other means (3.68) was not related to study progress (t (305) =1.37, p=.17).

6.19.11 Demographics

No significant differences in study progress was observed by gender (t (297) =-.88, p=0.38), ethnicity ($F_{4,287}$=.80, p=.53), country of study ($F_{4,291}$=.36, p=.84). full-time v part-time status (t (301) =1.13, p=.26), field of study (science v non-science students; t (299) =-.09, p=.93) and nationality ($F_{5,295}$=1.30, p=.27).

6.20 Modelling Study Progress

Based on the analyses above, a general linear model of satisfaction with study progress was constructed. This included predictor variables which were technology use-related, and variables concerned with psychological health and well-being. Technology use-related variables entered were preference for physical/digital copies of work, difficulty of using/learning software applications, hours spent on a typical day on a computing device, and I tend to spend more time on the Internet than intended. The health/well-being variables were problems as a result of spending time on the Internet (sleep, social life, family life, exercise), current general health, perceived stress and the effect of the COVID-19 pandemic on study. All variables were entered as fixed factors except hours spent on a computing device, which was entered as a covariate. Assumptions of homogeneity of error variance ($F_{1,278}$=1.64, p=.56) were met. The final model explained 26% of the variance in study progress ($F_{40,239}$=3.49, p<.001; Partial eta^2=.36, adjusted R^2=.26). Results of the analysis are shown in Table 6.1 and in Fig 6.21 which shows the relationship between the observed and predicted values for satisfaction with study progress.

Table 6.1 ***General Linear Model of Satisfaction with Study Progress***

	Partial eta^2	P
Technology Use-Related Variables		
Prefer digital to physical copies when reading*	.031	.04
Spend more time on the Internet than intended	.025	.10
Hours in total spent on computing devices on a typical day*	.022	.02
Find software applications difficult to use/learn	.013	.52
Well-Being Variables		
General Health*	.039	.04
Effect of Pandemic on Study**	.049	.01
Perceived Stress*	.039	.04
Time online affects exercise	.030	.11
Time online affects social life	.012	.56
Time Online affects family life	.020	.29
Time online interferes with my sleep**	.065	.002

* p≤.05 ** p≤.01

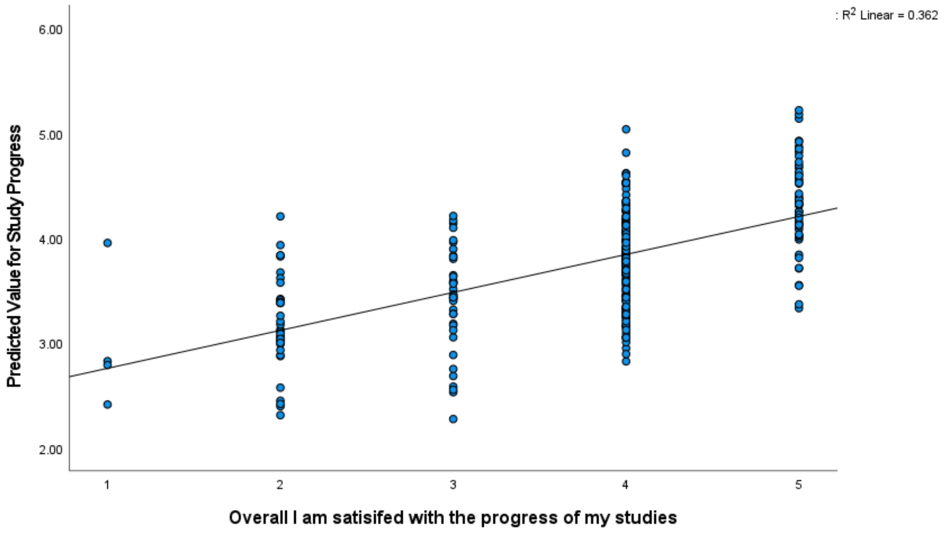


Figure 6.21 Relationship Between Observed and Predicted Satisfaction with Study Progress.

In the initial model several variables significantly predicted satisfaction with study progress; these were, preferring digital to physical copies when reading, amount of time spent on computing devices, general health, effect of the pandemic on study, perceived stress, and time online interfering with sleep, which produced the largest effect size. As indicated, the model was further applied in two distinct periods. The first covered the period up until mid-July 2022 before COVID restrictions ended on university campuses, and the second, the period from Mid-July to November 2022. Prior analysis of the single item measure showed that studies were significantly more affected by the pandemic in the first period (2.66 cf. 2.39; t (307) =-2.36, p=.019).

Results from application of the model in the two periods are shown in Table 6.2. The predictive ability of the model during the first period (Adjusted R^2 =0.39) was much greater than for the second (Adjusted R^2 =0.20). Treating the multiple correlation coefficient 'R' for these two samples as a simple correlation coefficient (for Period 1, R=.62; for Period 2, R=.45), permits Fisher-Z transformations to be applied to assess whether they differ significantly. This found the model's predictive power in Period 1 was significantly greater than in Period 2 (z=2.44, p=.041). Table 6.2 shows three variables (preferring physical to digital copies, the effect of the pandemic on study, and time online interferes with my sleep) exhibited much greater effect sizes in Period 1. Time online interferes with sleep had the largest effect.

Table 6.2 ***General Linear Model of Satisfaction with Study Progress in Two Periods of Time***

	Period 1 Until Mid-July 2022	R^2 .39	Period 2 Mid-July 2022-Nov 2022	R^2 .20
	Partial eta^2	p	Partial eta^2	p
Technology Use-Related Variables				
Prefer digital to physical copies when reading	.102	.03	.048	.26
Spend more time on the Internet than intended	.021	.55	.035	.28
Hours on computing devices on a typical day	.029	.09	.036	.04
Find software applications difficult to use/learn	.071	.12	.097	.03
Well-Being Variables				
General Health	.045	.34	.048	.25
Effect of Pandemic on Study	.083	.07	.029	.53
Perceived Stress	.061	.18	.050	.23
Time online affects exercise	.058	.20	.034	.44
Time online affects social life	.039	.42	.078	.07
Time Online affects family life	.034	.48	.045	.29
Time online interferes with my sleep	.162	.002	.072	.09

To test whether each differed in their effect on study progress across the two periods, three further general linear models were computed. Each included an interaction term with study period for the relevant variable, with all other terms in the above model as main effects. Results, (Table 6.3), suggest the three variables exerted a significantly greater effect during the first period of data collection.

Table 6.3 ***Results for General Linear Model, Change in Effect Size Over Time.***

Interaction term with Time Period	Partial eta^2	p
Prefer digital to physical copies when reading*	.021	.055
Effect of Pandemic on Study***	.048	.001
Time online interferes with my sleep**	.022	.047

* p<.10 ** p<.05 *** p<.01

6.21 Helpfulness and Difficulty of Technology

Factor analysis with varimax rotation was undertaken to investigate the underlying structure of items assessing the helpfulness of different types of software. Sampling adequacy for this was satisfactory (Kaiser–Meyer–Olkin =0.68). Four factors emerged accounting for 61.4% of the variance. The factor structure is presented below (Table 6.4).

Table 6.4 ***Rotated Factor Structure of Helpfulness of Different Technologies****

	Component			
	1	2	3	4
	20.07%	14.58%	13.93%	12.86%
I find the software I use for presentations helpful.	.75			
I find the software I use for video conferencing helpful	.71			
I find the technologies for receiving information helpful.	.68			.49
I find using email helpful in my studies.	.60			
I find the main software I use for word processing helpful	.52			
I find the specialist software I use helpful.		.79		
I find the software I use for quantitative data analysis helpful.		.79		
I find the software I use for online data collection helpful.			.86	
I find the software I use for qualitative data analysis helpful.			.68	
I find using instant messaging helpful in my studies.		.		.75
I find the technologies for recording lessons helpful.			.47	.62

* Only factor loadings >0.30 are shown

Factor One has high loadings for presentations, videoconferencing, and communication technologies. This may be considered as representing *academic communication.* Factor Two has high loadings for specialist software and quantitative analysis and represents the helpfulness of *data analysis*. Factor Three concerns the helpfulness of software concerned with *collecting data, analysing and interpreting it qualitatively.* Factor Four, has high loadings on receiving information, instant messaging, and recording. It is labelled as being concerned with *information receipt and storage.*

With two of these factors concerning helpfulness of quantitative and qualitative software respectively, these were subjected to further analysis. The helpfulness of these in relation to length of time studying and study discipline were examined by an Analysis of Variance and Independent t-test respectively. There was a trend for helpfulness of both quantitative ($F_{5,299}$=2.06, p=.071) and qualitative software ($F_{5,1703}$=2.14, p=.063) to vary with study time. Independent t-tests found a significant difference by study discipline for quantitative (science=4.50, non-science=4.18; t (292) =3.49, p<.001) (Fig 6.22) but not qualitative software (science=3.68, non-science=3.90; t (170) =-1.48, p=.14). This points to science students finding software for quantitative analysis significantly for useful than non-science students.

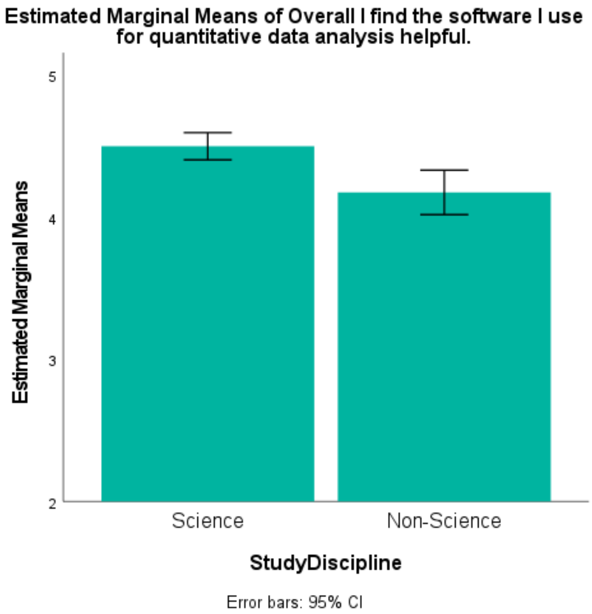


Figure 6.22 Helpfulness of quantitative software by Study Discipline (95%CI)

Overall, these findings reveal the underlying components to how the helpfulness of technology is construed, with the further suggestion that the helpfulness of quantitative software varies with both study time and field of study.

6.22 Difficulty in Using/Learning Software Applications

This section reports inferential analyses concerning difficulties in the learning and use of research-relevant software packages by doctoral students. Following up on the earlier descriptive results (Section 6.14), these tests assessed the correlates (health and well-being, stress, training, helpfulness of software, affective reactions to software use, demographic) of the reported difficulties.

Difficulty in using/learning software applications was significantly correlated with poorer current health (r (302) =-.17, p=.003), worsening health over the previous year (r (301) =-.16, p=.007), perceived difficulty paying bills (r (300) =.18, p=.002) and reporting audio discomfort during videoconferencing (r (307) =.16, p=.005). There were no significant relationships with perceived stress (r (301)=.04, p=.54), having received training in technology use (r (301)=-.03, p=.58), receiving information from lecturers face-to-face (r (302)=-.03, p=.56), study discipline (science=2.40, non-science=2.60; t (294) =-1.63, p=.10), nationality ($F_{5,290}$=.72, p=.61), gender (t (292)=1.25, p=.21), and ethnicity (t (285) =1.76, p=.08).

Greater difficulty in using/learning software was related to finding several forms of software less helpful: for quantitative analysis (r=-.22, N=294, p<.001), for specialist analysis (r (244) =-.18, p=.005), for videoconferencing (r (200) =-.12, p=.043) and for receiving information (r (285) =-.17, p=.005). No significant relationships were found between difficulty in using/learning software and whether participants had received training in any area. When difficulty in using/learning software applications was treated as a binary variable (Y/N), significant differences in levels of negative emotions when accessing information sources were reported. Thus, greater frustration (t (305) =4.04, p<.001), greater anxiety (t (304) =-2.04, p=.04) and less relaxation (t (307) =-2.70, p=.024) were reported by those reporting difficulty (Fig 6.23).

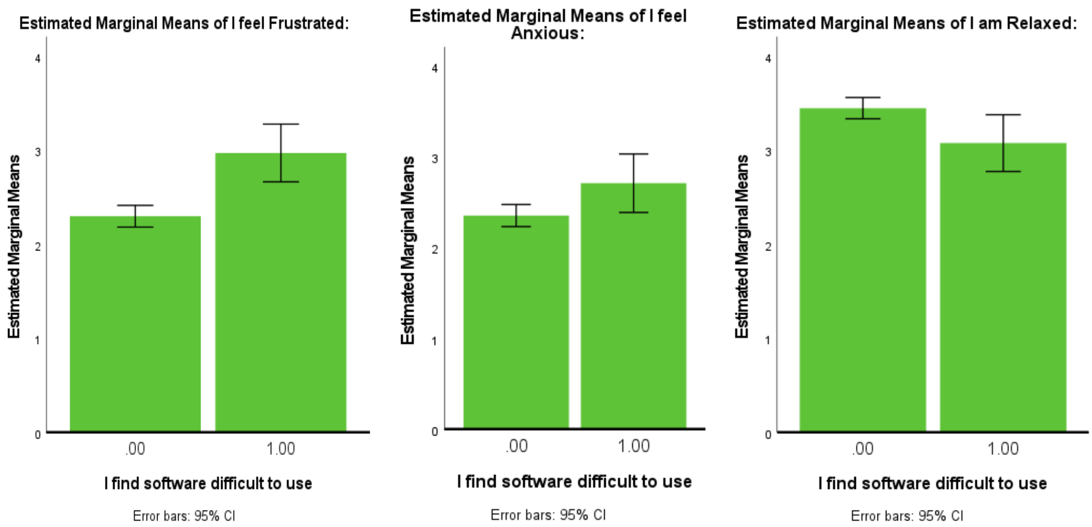


Figure 6.23 Difficulty using software by Negative Emotions (95% CI) (1=Yes, 0=No)

Those reporting no difficulty were significantly more likely to use technology regularly in their studies compared to those who reported difficulty (strongly agree; 25.6% v 9.9%; Odds-Ratio=3.76, Fisher's Exact p=.009). Reported difficulty was not associated with length of time studying (χ^2 (5, 308) =3.06, p=.69).

Overall, results suggest difficulty using software is associated with poor health, negative emotional reactions to using information sources, using technology less regularly when studying, finding specific forms of software less helpful and reporting less satisfaction with study progress. The combined effects of these in a logistic regression provided a good fit to the data (χ^2 (12, N=213) =27.80, p=.006; Hosmer & Lemshow χ^2 (8) =10.48, p=.24), with an effect size of between .122 (Cox & Snell R^2) and .242 (Nagelkerke R^2). Overall, the model correctly classified 89.7% (62.5% (5/8) of those who found software difficult to use and 90.7% (186/205) of those who did not). The strongest effect was for feeling frustrated when accessing information sources (Wald χ^2=6.51, Odds Ratio=1.95, p=.011).

The following sections (6.23 – 6.26) deal with predicting affective reactions (negative and positive) when accessing electronic information sources.

6.23 Negative Emotions toward accessing electronic information sources

Significant correlations were reported between the sum of negative emotions and the following variables: helpfulness of software for quantitative (r (295)=-.19, p=.001), and qualitative analysis (r (171)=-.17, p=.024), helpfulness of videoconferencing (r (302)=-.14, p=.014), quality of audio in videoconferencing software causes discomfort (r (303)=.19, p<.001), I find software difficult to use (r (297)=.25, p<.001), sum of problems caused by spending time online (r (296)=.26, p<.001), happiness with time management (r (301)=-.23, p<.001), current health (r (304)=-.14, p=.013), the COVID pandemic has affected my studies (r (303)=-.17, p=.003), perceived stress (r (302)=.30, p<.001), satisfaction with study progress (r (302)=-.26, p<.001), feeling interested (r (304)=-.26, p<.001), feeling engaged (r (302)=-.36, p<.001) and feeling relaxed (r (304)=-.51, p<.001).

6.24 Modelling Negative Emotions

The frequency distribution for sum of negative emotions is relatively normal (Fig 6.17), with neither excessive kurtosis (0.70) nor skewness (2.70). The Shapiro-Wilk test suggested the distribution was not normal (W=.97, df=304, p<.001), though Q-Q plots suggested departure from normality is trivial and likely a consequence of increased sensitivity from the sample size.

Based on the correlational analyses, a multiple regression was undertaken to determine which factors predicted negative emotional reactions to accessing information sources. The variables above were entered as predictors, in addition to gender, length of time studying and full-time/part-time status. The analysis produced five significant predictors, explaining 43.4% of the variance ($F_{5,152}$=23.36 p<.001; R^2=0.43; Fig 6.24). Perceived stress (Beta=.29, p<.001) was positively related to negative emotional reactions, while feeling relaxed (Beta=-.38, p<.001), feeling engaged (Beta=-.18, p=.007), and helpfulness of quantitative (Beta=-.18, p=.005) and qualitative software (Beta==-.13, p=.048) were negatively related. Negative emotional reactions (boredom, frustration and anxiety) then appear predicated on how helpful the software for quantitative and qualitative analysis was judged to be, coupled with an absence of relaxation and engagement.

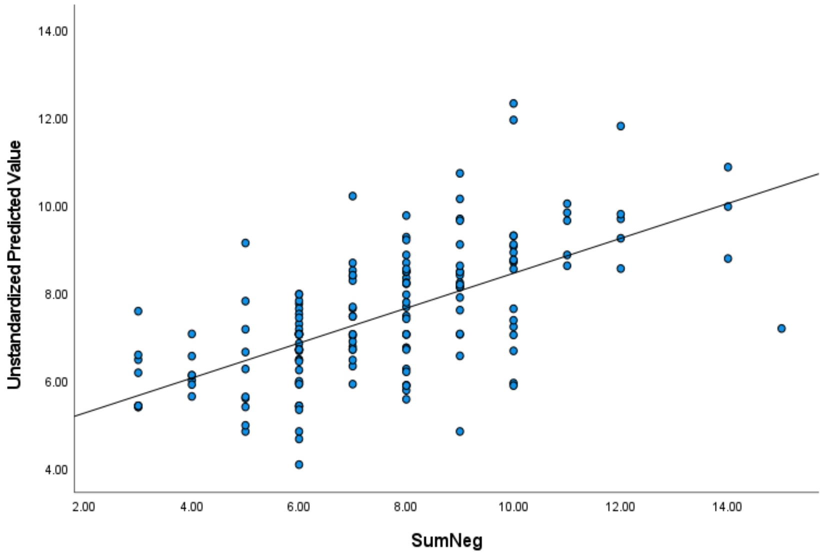


Figure 6.24 Relationship Between Actual and Predicted Scores for Sum of Negative Emotions.

6.25 Positive Emotions Toward Accessing Electronic Information Sources

Significant correlations were reported between sum of positive emotions and the following variables: finding software difficult to use (r (300) =-.14, p=.03), helpfulness of software for; word processing (r (305)=.31, p<.001), online data collection (r (250)=.31, p<.001), quantitative analysis (r (298)=.13, p=.022), presentations (r (304)=.20, p<.001), receiving information (r (287) =.25, p<.001), recording lessons (r (193)=.15, p=.036), videoconferencing (r (305)=.26, p<.001), happiness with time management (r (303) =.18, p=.002), problems caused by spending time on the Internet (r (299)=-.13, p=.023), current health (r (307)=.15, p=.009), the COVID pandemic has affected my studies (r (306)=.13, p=.021), perceived stress (r (306)=-.21, p<.001), satisfaction with study progress (r (305)=.22, p<.001), feeling frustrated (r (305)=-.38, p<.001), feeling bored (r (307)=-.47, p<001), feeling anxious (r (304) =-.33, p<.001) and study field (r (301)=.12, p=.034; non-science participants reported more positive emotions).

6.26 Modelling Positive Emotions

The distribution (Fig 6.18) appears relatively normal although kurtosis (3.07) and skewness (2.97) were above recommended limits and the Shapiro-Wilk test suggested the distribution departed from normality (W=.96, df=307, p<.001). As before, departure from normality is a likely consequence of increased sensitivity from the sample size. Following correlational analyses, a multiple regression was conducted to determine the factors predictive of positive emotional reactions to accessing information sources. The variables above were entered as predictors, in addition to gender, length of time studying and full-time/part-time status. The analysis produced six significant predictors explaining 44.2% of the variance ($F_{6,204}=28.77$, $p<.001$; $R^2=0.44$ (Fig 6.25).

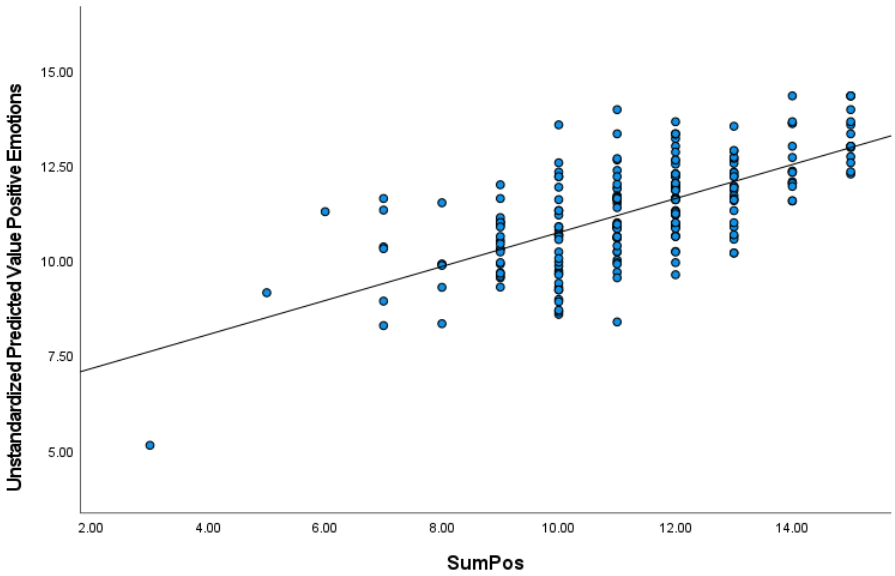


Figure 6.25 Relationship Between Actual and Predicted Scores for Sum of Positive Emotions.

Feeling bored (Beta=-.32, p<.001), frustrated (Beta=-.16, p=.006) and anxious, (Beta=-.16, p=.006) were negatively related to total positive emotional reactions, while helpfulness of software for word processing (Beta=.23, p<.001), online data collection (Beta=.17, p=.002) and technologies for receiving information (Beta=.12, p=.035) were positively related. Positive emotional reactions (interest, engagement, relaxation) then, appear predicated on how helpful the software for collecting, receiving, and communicating information was judged, coupled with absence of negative emotions.

6.27 Preference for Campus-Based or Online Education

While descriptive findings in Section 6.7 and 6.8 documented the reasons for these preferences. The cross-tabulation analyses in this section were undertaken to examine whether there are statistically significant group differences associated with these choices.

Preference for campus-based or online education was significantly associated with full-time/part-time status (Fisher's Exact p<.001) (Fig 6.26).

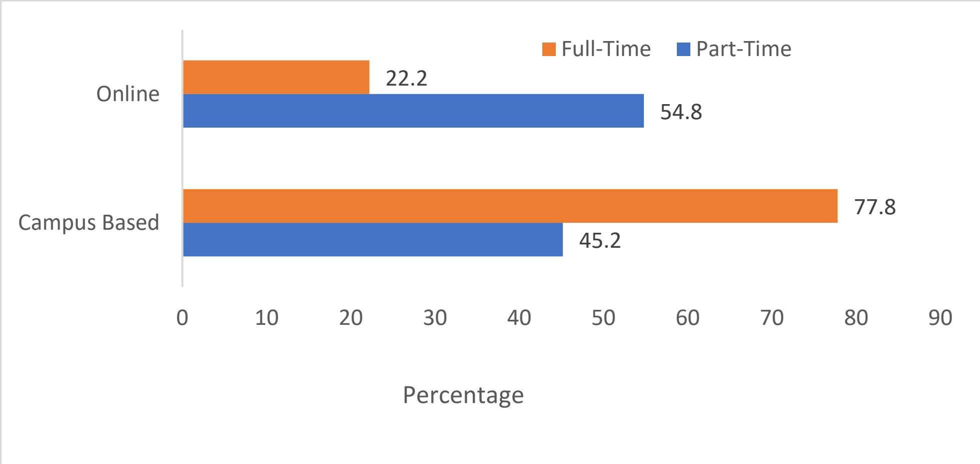


Figure 6.26 Relationship Between Full/Part-Time Status and Preference for Campus/Online Study

Over half those pursuing part-time study (N=17, 54.8%) favoured online education, compared to over one-fifth (N=60, 22.2%) of those studying full-time, with campus-based study preferred by 77.8% of full-time (N=210) but only 45.2% (N=14) of part-time students. In addition, preference for campus-based study was greater in science (N=167, 79.1%) than non-science students (65.9%; N=58, Fisher's Exact p=.019) (Fig 6.27). In cross tabulations with gender, ethnicity, country of study and nationality, no significant associations were found (p>.15 in all cases).

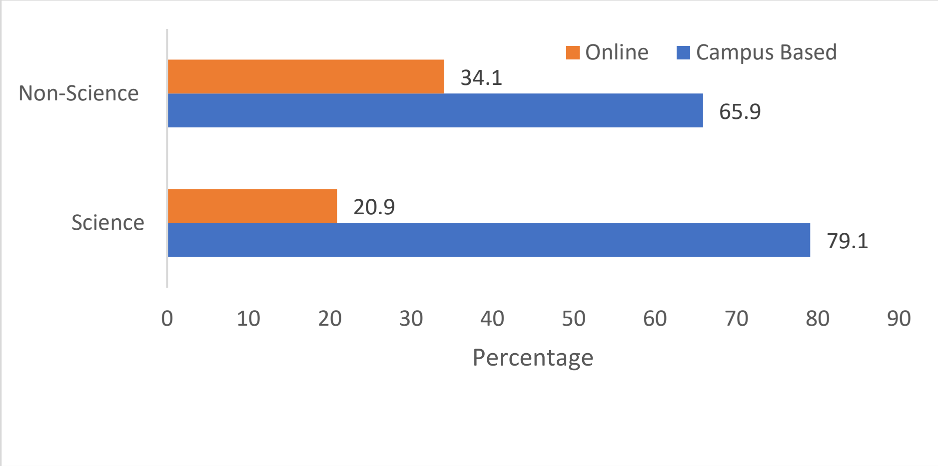


Figure 6.27 Relationship Between Field of Study and Preference for Campus/Online Study

Further analyses examined the principal reasons for preferring campus-based study (social interaction and necessity of campus-based education). These were cross tabulated with gender, ethnicity, country of study and study discipline. No significant associations were found (Fisher's Exact p>.10 in all cases). In addition, whilst no significant association was found between full-time and part-time status and social interaction as a reason for preferring campus-base study (Fisher's Exact p>.10), those who studied full-time were more likely to consider a campus education necessary (16.3% v 0%; Fisher's Exact p=.011). Part-time students instead were more likely to remark on the flexibility offered by online study (40.0% v 16.7%; Fisher's Exact p=0.005).

6.28 Time Management

Analyses in this section concern inter-relationships between happiness with time management and problems associated with spending time online. Happiness with time management was significantly negatively correlated with: spending more time on the Internet than intended (r (301) =-.36, p<.001); time online affecting how much exercise is taken (r (303) =-25, p<.001), affecting social life (r (304) =-.30, p<.001), family life (r (302) =-.26, p<.001), and quality of sleep (r (305) =-.37, p<.001) as well as perceived stress (r (304) =-.25, p<.001).

'Spending time online affects how much exercise I take' was negatively correlated with self-rated health (r (305) =-.21, p<.001), and health compared to one year ago (r (304) =-.13, p=.02). 'Spending time online interferes with the quality of my sleep' was negatively correlated with self-rated health ($r(306) = -.17$, $p = .002$), health compared to one year ago ($r(306) = -.12$, $p = .032$), perceived stress ($r(306) = .22$, $p < .001$) and 'The COVID pandemic has affected my studies' ($r(306) = -.13$, $p = .029$).

In a multiple regression, the combined effects of time spent online on sleep quality, exercise, family, and social life upon happiness with time management found these accounted for only 15% of the overall variance ($F_{4,294} = 14.53$, $R^2 = 0.15$, $p < .001$). Interference with sleep quality was the only significant variable ($Beta = -.49$, $p < .001$).

Further post-hoc analyses were undertaken to assess the potential mediational effect of the same variables (problems caused by spending time online on exercise, social life, family life and sleep) on the relationship between happiness with time management and satisfaction with study progress. As is shown below there was no evidence that these variables mediated the relationship.

A regression model with satisfaction with time management as the sole predictor of satisfaction with study progress was highly significant ($F_{1,296} = 48.54$, $R^2 = 0.14$, $Beta = 0.38$, $p < .001$). However, addition of problems caused by spending time online (exercise, social life, family life and sleep) to this model, did not affect this relationship ($Beta = 0.38$, $p < .001$) and had no effect on the predictive efficacy of the model ($F(change)_{1,294} = .01$, $R^2(change) = 0.00$).

Fig 6.28 shows the different types of internet related activity engaged in. Work related activity was most frequently cited as the main type.

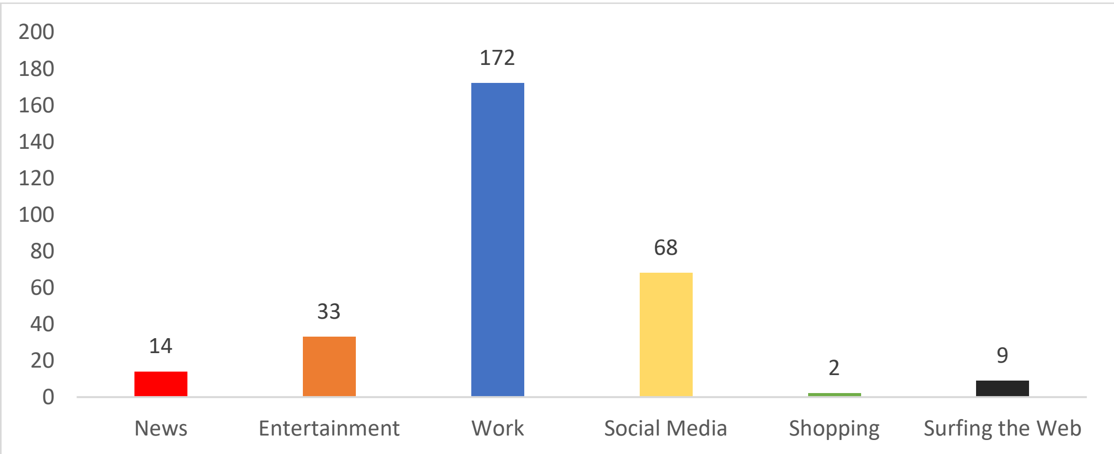


Figure 6.28 Type of Internet Activity: Most Time Spent on a Typical Day

Cross tabulations were undertaken to assess whether group variables (gender, ethnicity, country, study discipline, full/part time status and length of time studying) were associated with whether work-related activity was selected as the type of activity most engaged in. No significant associations were found ($p>.40$ in all cases).

Correlational analysis found that range of social media use was not significantly related to time management (Table 6.5).

Table 6.5 ***Correlations with Range of Social Media Use***

Variable	r	N	P
Hours spent on a computing device	-.00	300	.96
Spending more time on the Internet than intended	.07	303	.23
Spending time online			
interferes with quality of sleep	.03,	307	.59
affects how much exercise I take	-.01	305	.93
affects my social life	-.07	306	.24
affects my family life	-.02	304	.79
Happiness with time management	.01	305	.90

The summary scale 'problems caused by spending time online', was examined in relation to several variables concerning technology use, health and demographic variables. These results are presented below.

6.29 Technology, Health and Well-being

Here, the focus is on the relationships between technology use, the consequences of that use, emotional reactions and self-reported health and well-being.

i) **Technology**

A) *Emotions felt when using information sources*.

'Problems caused by spending time online' was positively correlated with feeling frustrated ($r(299)=.21$, $p<.001$), and anxious ($r(298)=.26$, $p<.001$) and negatively correlated with feeling relaxed ($r(301)=-.19$, $p=.001$). There was no significant relationship with feeling interested ($r(301)=-.02$, $p=.76$), engaged ($r(299)=-.09$, $p=.14$), or bored ($r(298)=.10$, $p=.08$).

B) I use technology regularly in my studies

As most respondents answered strongly agree/agree to this question, an independent samples t-test was conducted to assess whether problems caused by spending time online differed between these two response categories. No significant difference was found (13.04 v 13.45; t (292) =-.65, p=.52).

C) I spend more time on the Internet than intended

This was significantly positively correlated with problems caused by spending time online (r (300) =.30, p<.001).

D) When using video conferencing software, the quality of the audio causes me discomfort.

This was significantly correlated with problems caused by spending time online (r (300) =.12, p=.034).

E) Total hours spent on a typical day using computing devices

This was not significantly correlated with problems caused by spending time online (r (294) =.07, p=.20).

F) Social media use (number of platforms used).

There was no significant relationship with problems caused by spending time online (r (301) =-.02, p=.78).

ii) **Health**

'Problems caused by spending time online' was significantly negatively correlated with general health (r (301) =-.23, p<.001), health compared to one year ago (r (300) =-.15, p=.011) and the COVID pandemic has affected my studies (r (300) =-.14, p=.016). It was significantly positively correlated with perceived stress (r (300) =.17, p=.002) and marginally significantly correlated with difficulty paying bills (r (299) =.10, p=.07).

iii) **Demographic variables**

The analyses here explore whether group differences exist in relation to data collection practices, problems caused by spending time online and the helpfulness of software.

Gender

There was no significant gender difference (females=13.29 v males=12.78; t (291) =1.17, p=.24) in number of problems caused by spending time online, although differences in technology use for data collection were found. Females were more likely to use technology for collecting data, both via a website (50.8%, N=96 cf. 33.9%, N=38; Fisher's Exact p=.006) and videoconferencing (52.9%, N=100 cf. 27.7%, N=31; Fisher's Exact p<.001) (Figs 6.29, 6.30).

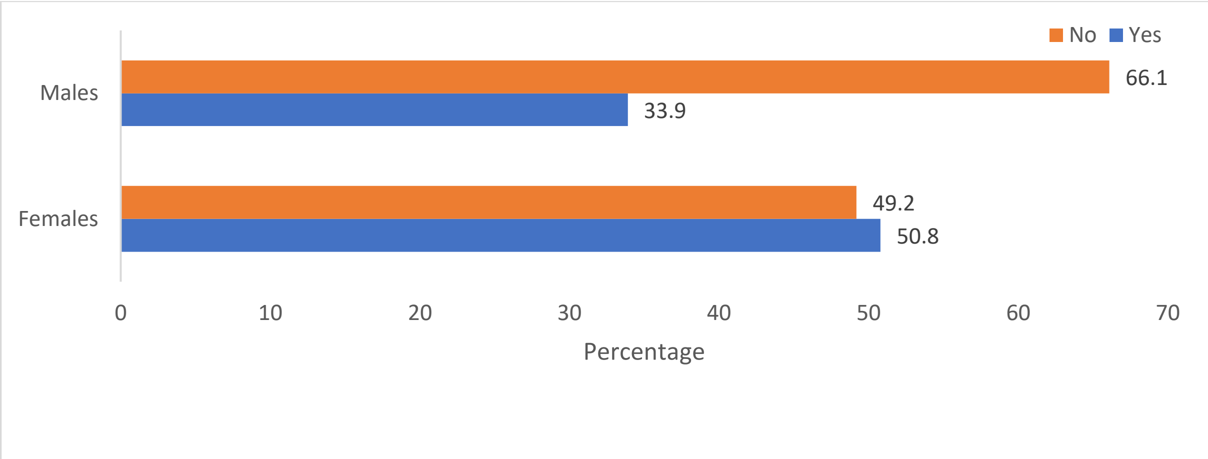


Figure 6.29 Technology Use for Collecting Data via Website by Gender

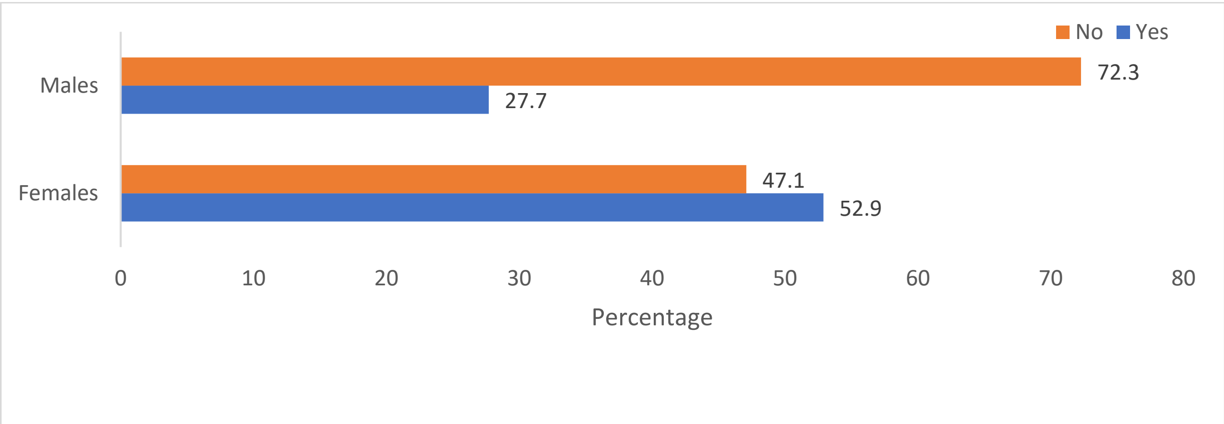


Figure 6.30 Technology Use for Collecting Data via Videoconferencing by Gender

Gender was also significantly associated with how helpful software for online data collection was viewed (χ^2 (2) =7.21, N=246, p=.027). A greater proportion of females than males found the software helpful (71.2%, N=111 cf. 55.5%, N=50) (Fig 6.31).

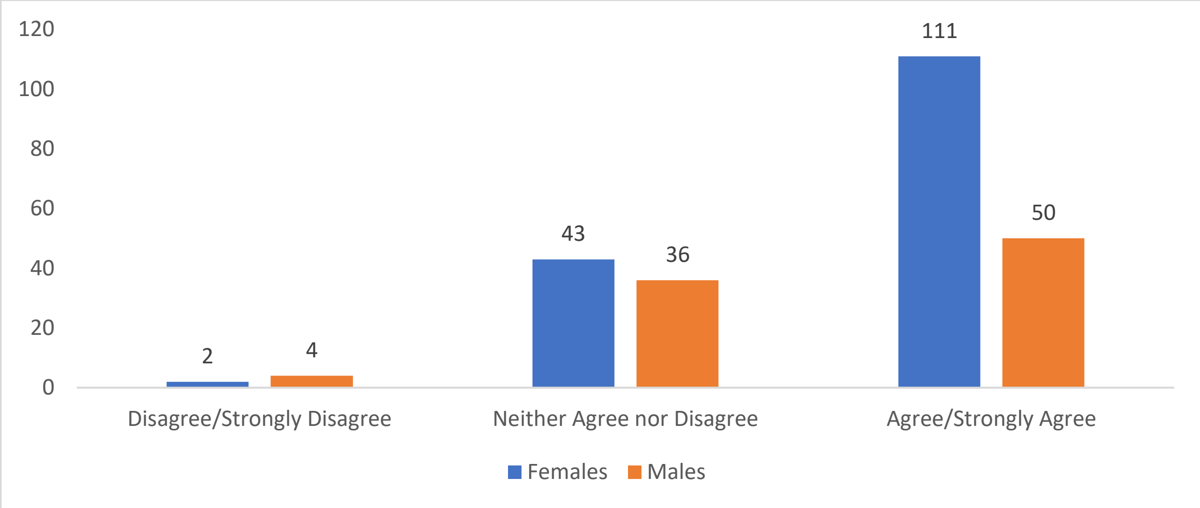


Figure 6.31 Helpfulness of Software for Online Data Collection by Gender

Ethnicity

Whilst White participants reported fewest problems from spending time online (12.63, SD=3.54) and Arab participants the greatest (14.71, SD=2.90), these were not significantly different ($F_{4,281}$ =1.94, p=.11). Similarly, no significant variation with ethnicity was observed for how helpful software for online data collection was ($F_{4,233}$=.53, p=.71).

Country of Study

No significant differences by country were found in number of problems caused by spending time online ($F_{4,287}$=.52, p=.72) or the helpfulness of software for online data collection ($F_{4,240}$=.14, p=.97).

Length of Time Studying

The sum of problems from spending time online was unrelated to length of time studying ($F_{5,294}$=.55, p=.74) but was related to helpfulness of software for online data collection ($F_{5,246}$=2.75, p=.02). ($F_{5,246}$=2.75, p=.02). Lowest ratings for helpfulness were given by those in their first year (3.77), with highest given by those studying for over 5 years (4.17). Furthermore, length of time studying was associated with collecting data through a website

(χ^2 (5, N=308) =10.67, p=.058). Only in years one and two did most respondents (58.6%) report collecting data. There was no association between length of study time and data collection via videoconferencing (χ^2 (5, N=308) = 9.99, p=.16).

Study Discipline

Problems caused by spending time online exhibited no significant difference between science and non-science students (12.93 v 13.40; t (293) =1.01, p=.31). However, non-science students reported finding software more helpful for online data collection than science students (4.10 v 3.76; t (245) =2.90, p=.004) (Fig 6.32).

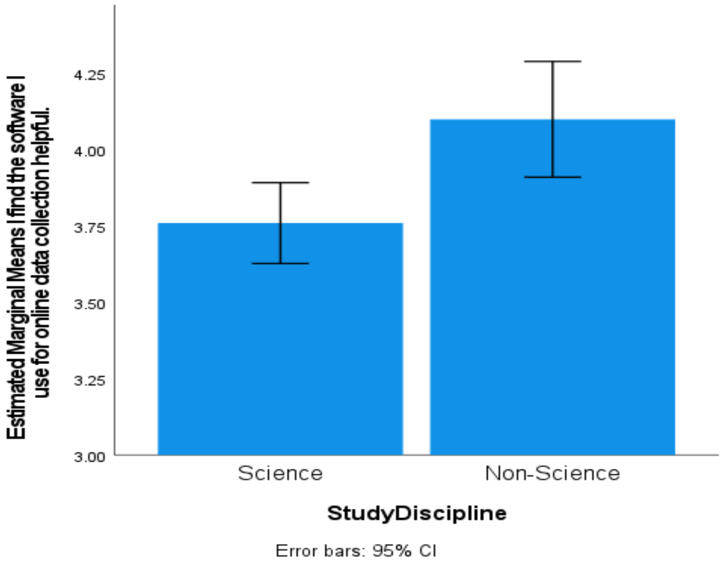


Figure 6.32 Helpfulness of Software for Data Collection by Study Discipline (95%CI)

Non-science students were also more likely to use technology for collecting data, via a website (68.18%, N=60 cf. 33.95%, N=73; Fisher's Exact p<.001) and via videoconferencing (77.3%, N=68 cf. 28.8%, N=62; Fisher's Exact p<.001). (Figs 6.33, 6.34).

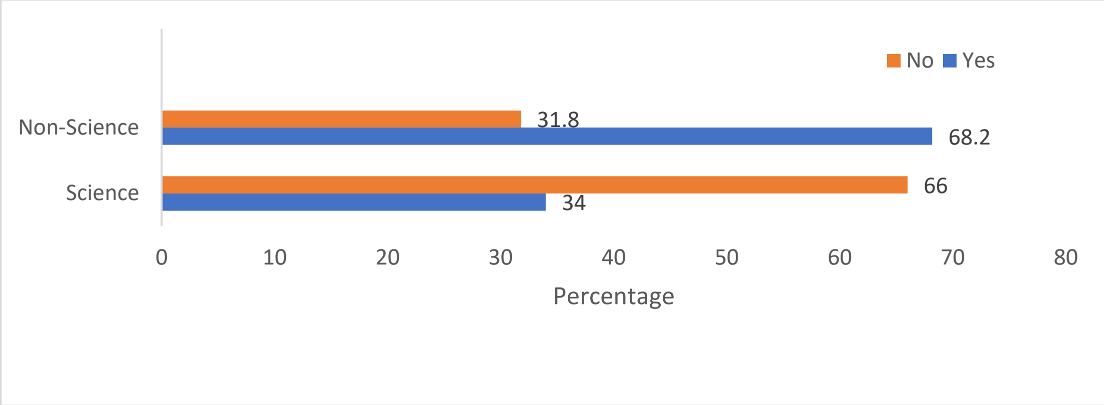


Figure 6.33 Technology Use for Collecting Data through a Website by Study Discipline

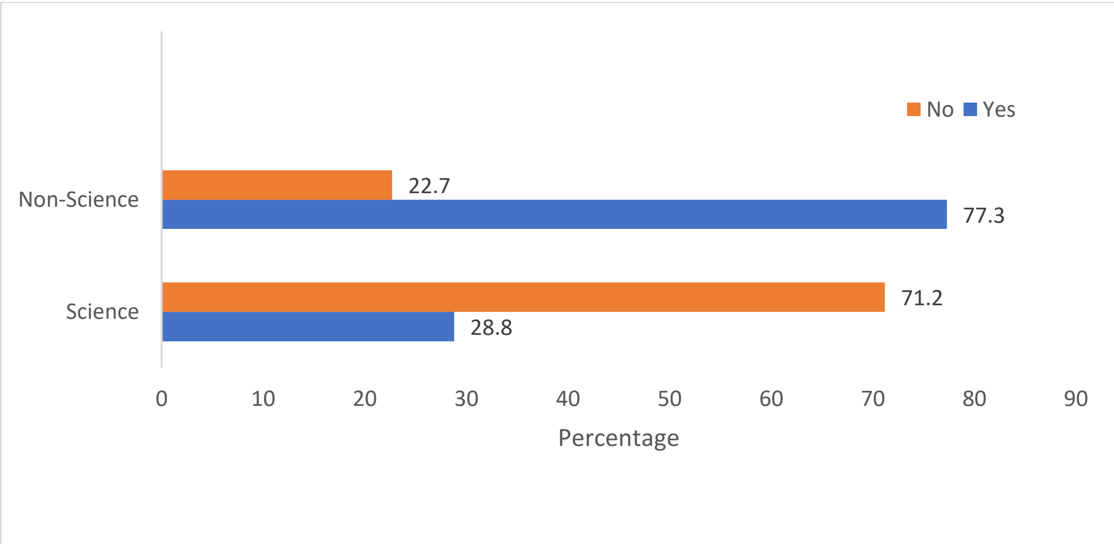
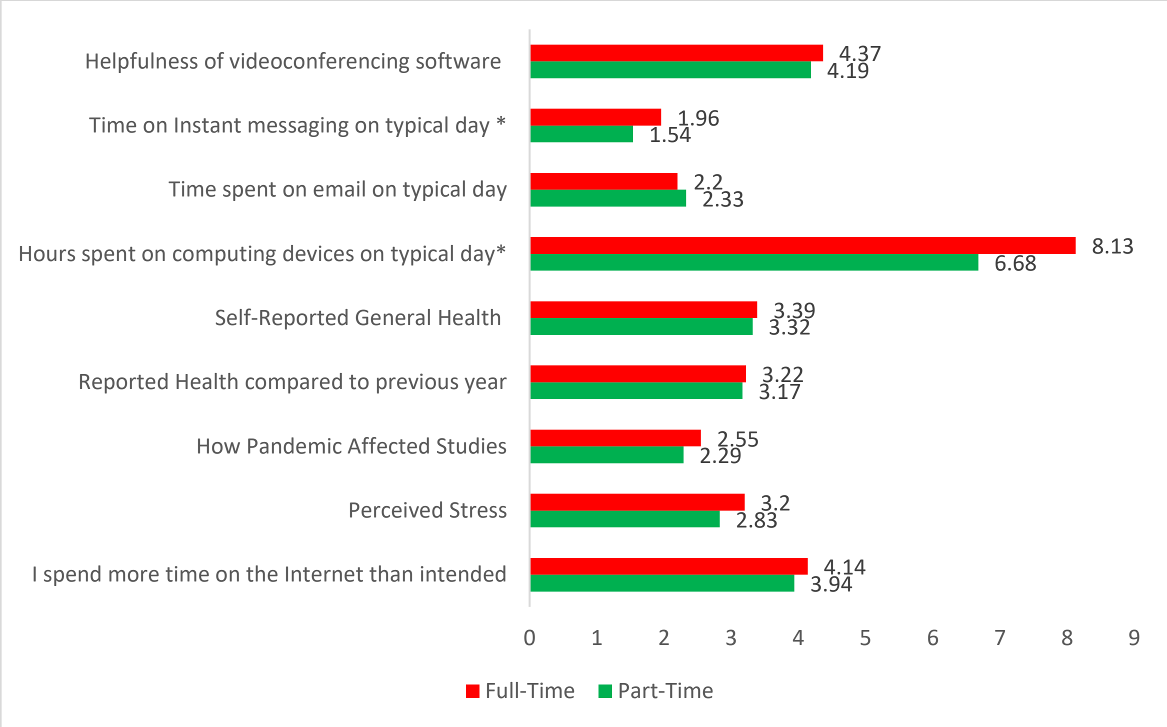


Figure 6.34 Technology Use for Collecting Data via Videoconferencing by Study Discipline

Overall, it can be seen that ‘problems caused by spending time online’ is significantly related to spending more time on the Internet than intended, feeling frustrated, anxious, and not relaxed when using information sources, suffering discomfort from audio quality when videoconferencing and reporting greater perceived stress and poorer health. These relationships attest to the validity of the measure and suggest online time may be problematic for some respondents.

Full-Time/Part-Time Status

Independent t-tests were used to compare full- and part-time students on several indicators of technology use and self-reported health (Fig 6.35). Full-time students reported spending significantly more time on instant messaging (1.96 v 1.54 hours; t (297) =2.13, p=.034) and on computing devices on a typical day (8.13 v 6.68 hours; t (294) =2.31, p=.022). However, there were no significant differences between full and part-time students on happiness with time management, spending time online affects family life, social life, and how much exercise is taken (p>0.15 in all cases).



* p≤.05

Figure 6.35 Technology use and health in relation to Full/Part-Time status.

6.30 Communication with Other Students and Lecturers

The analyses here pertain to Research Question 4 and concern the extent to which technology facilitates or hinders effective communication with teachers, supervisors and other students.

Videoconferencing

Communicating with students via videoconferencing was positively related to satisfaction with study progress (r=.24, N=305, p<.001), though its use with lecturers was not (r=.07, N=302, p=.25). Videoconferencing to communicate with students (χ^2 (3, 299) =1.53, p=.68) and staff (χ^2 (3, 296) =5.49, p=.14) were not associated with gender. Frequency of using videoconferencing, either with fellow students (χ^2 (3, 301) =5.65, p=.13), or staff (χ^2 (3, 298) =5.69, p=.13) was not related to study discipline.

Instant Messaging

Preference for instant messaging to communicate with students (χ^2 (4, 294) = 1.75, p=.78) and staff (χ^2 (4, 299) =6.36, p=.17) was not associated with gender. However, they were significantly associated with study discipline. Non-science students were more likely to strongly agree that they preferred using it when communicating with other students (14.0% cf. 1.4%; χ^2 (4, 296) =32.26, p<.001) and with staff (37.94% cf. 21.0%, χ^2 (4, 301) =10.65, p=.031).

This completes presentation of the survey results. They are discussed in the next chapter.

Chapter 7: Phase 1 - Survey Discussion

7.1 Overview

In this chapter the survey findings are interpreted in relation to existing literature and situated within the broader remit of understanding doctoral students constructed experiences of digital engagement.

7.1.1 Benefits

The descriptive data highlighted several issues. It is evident that doctoral students are reliant on technology, which will likely have increased during the pandemic. Uses of technology were diverse and include communication with staff and students, personal time management, accessing information, and the collection, management and analysis of data. Respondents reported various sources of satisfaction which came with studying in a technology rich environment. Foremost amongst these were: direct help with study, ability to access information in a global communications environment, maintaining communication, managing both data and time and affording opportunities to work and study flexibly while considering health needs.

7.1.2 Problems

While technology conferred many benefits, it also introduced problems. In seeking to balance demands of digital learning and desire to meet one's own needs, several specific but related challenges were described; (1) distraction and information overload, (2) time management, (3) physical health problems, (4) addiction and (5) technical issues associated with using technology. In line with existing literature (Lee, et al., 2022; Hilty et al., 2022; JISC, 2024) possibilities for distraction were evident in many survey responses. While a majority reported work-related online activity took up more time than competing sources of internet activity, many, nevertheless, acknowledged spending more time engaged on social media than other kinds of activity. This must be interpreted with caution, not merely because of the self-reported nature of the data but also because a clear distinction between pedagogically oriented internet-related activity and social media use cannot always be made (Allgaier, 2020). You tube channels for example contain a wealth of scholarly material and practical advice for using software, while Twitter and Facebook can also be utilised for networking and exchanging academic information.

7.1.3 Well-Being and Emotional Cost of Technology

In line with previous work (Bennett & Folley, 2014), the current results suggest that the opportunities and benefits afforded by technology at students' disposal came with costs, some of which were emotional - in the form of reported anxiety and frustration – as well as compromised health and well-being. Many reported spending time online interfered with sleep quality, social and family life and their capacity to exercise. The stated detrimental effects of technology on these aspects of social and personal well-being, provides the kind of evidence which Wang et al. (2018) have called for, and adds weight to an emerging picture from recent studies (e.g., McDaniel & Drouin, 2019; Dienlin & Johannes, 2020). These are of added significance given the pandemic-induced disruptions. Approximately one-fifth of respondents reported their health had declined over the preceding year, with over half stating their health had been adversely affected by the pandemic. That the working environment can affect health is long established (e.g., Marmot et al., 1991; Marmot, 2010, 2020), although only relatively recently has this become a focus of interest in student populations (Richardson et al., 2022) and then, chiefly undergraduates. This study stands as a corrective to the comparative neglect of postgraduate life and well-being. It is not surprising that in it, respondents' satisfaction with their study progress was correlated with their health, whether the benchmark for this was assessed by current health, perceived stress, health behaviours or the effects of the pandemic. This supports work that poorer well-being in students is associated with delayed study progress and lower academic self-efficacy (Keating et al., 2013; Grøtan et al., 2019).

Before further considering the relationship between technology use and study progress, it is important to recognise that even in the technology-rich environment, in which respondents studied, a notable minority reported software applications were difficult to use or learn. This adds to evidence that some postgraduate's experience difficulty in utilising ICT (Nair & Pillay, 2004; Henderson et al., 2015). Such students are clearly disadvantaged, and analysis confirmed they were more frustrated, more anxious, and less relaxed when accessing information sources, with additional evidence that finding software difficult to use was correlated with financial difficulty. These adverse emotional reactions were, in addition, associated with less satisfaction with study progress. Whilst this lack of satisfaction was not directly related to the training respondents reported receiving, training is nevertheless important. Though a majority received training of some kind, a sizeable minority had not, echoing Gouseti's (2017) observation that training given to doctoral students is often limited.

7.1.4 Importance of the Human Element

Despite the benefits described, respondents did not favour a completely digital study environment. The human aspect in interacting with learning resources, including encountering academic staff and students, remained important. The importance of the interpersonal environment is supported by work showing improved learning outcomes as students resumed face-to-face course delivery following the online provision during the pandemic (Rizaldi et al., 2022). In a period when study was globally affected by the pandemic, a large proportion of respondents expressly preferred campus-based education, seeing in this, prospects for face-to-face interaction, building relationships and opportunities to direct and conduct empirical work on-site. The latter was not always possible remotely. In this regard, it is noted that non-science students, who were less likely to be affected by the necessity for campus-based study, were more likely to report finding on-line data collection helpful.

Many respondents thought that direct human interaction and on-site practical work could not be replicated virtually. Concerns about the limits of interacting with digital artefacts were also found in expressed preferences for physical copies of academic publications over electronic ones. This challenges previous assertions that graduate students prefer electronic journals over paper ones (e.g., Dange, 2010). One may speculate that an excess of pandemic-fuelled virtual learning has stimulated nostalgia for material artefacts. These concerns about the limits to on-line education were also observed in the perceived advantages and disadvantages of face-to-face over virtual engagement. A small proportion of respondents preferred a blended approach, combining aspects of both on-line and face-to-face education (Laiken et al., 2014; Cheung et al., 2023).

7.1.5 Institutionally Sanctioned Tools

In appraising the survey data, it was clear that engagement with technological tools and the decisions respondents make to use these cannot be viewed purely in terms of the functionality of the technology or a propensity to favour specific tools, whether for practical or emotional reasons. The observed reliance on technology, together with expressed preferences for certain software when word processing (Word), or engaging in quantitative analysis (Excel), qualitative analysis (NVIVO), work presentations (Powerpoint) and videoconferencing (Zoom and Teams) were plainly governed by factors external to respondents. The preferred tools and their availability, in all these spheres of activity, reflect the dominance of a small number of powerful technology corporations in educational settings – chief amongst them, Microsoft (Komljenovic et al., 2024).

This shaping of individual, technologically realisable goals via corporate supplied tools brings us into the realm of socio-technical systems, whereby individual creative choices are merged with levels of functionality and subscription options set by institutional and corporate players (Lee, 2018; Tomte, et al., 2019). Due to this increasing corporate intrusion into what was previously a private sphere of action, the era of personal computing is consigned to history –superseded by cloud-based computing, artificial intelligence, rental software, and intrusive advertising in individual workspace. These reflect the reality of a competitive, politically driven, corporate climate (Ren et al., 2019; Zuboff, 2019).

7.1.6 Technology Eco-System

In terms of the socio-technical nature of users' technological engagement, the post-PC era (Press, 1999) embraces a range of interlocking social, cognitive, emotional, interpersonal, ergonomic, and technological constraints, forming a complex system of tools, people and institution structures which remains poorly understood (Berry, 2017). Whether this imposes pedagogical constraints warrants attention. Behind the desire to understand this environment is a wish to enhance academic performance and communication in both individuals and the community (Zhu & Procter, 2015), as well as to identify efficient strategies for technological use in different learners, whether science or non-science-based, full, or part-time, male, or female, technologically experienced or not. How technology is employed to enhance the learning goals of diverse groups of students is largely an empirical question. However, the dominating presence of technology across campuses cannot be assumed to be an unquestioned good, nor should students' proficiency with it be assumed, as is evident in this study. It is noted that few expressed concerns over privacy and security issues. Nevertheless, such concerns may increase as the pedagogical environment becomes subject to increasing levels of technological management and surveillance.

7.1.7 Training Needs

Most respondents had received some form of training, with non-science students more likely to have received it. In principle, the goal of training is to acquire specific skills and knowledge, but it can also be aimed at addressing issues that hinder the acquisition of those skills. If training does not address a student's potential emotional difficulties in learning, its effectiveness can be reduced. The findings here are consistent with Vallade et al.'s (2021) model of technology adoption in which both positive and negative emotional reactions play an important role in learning, and support Weinstein's (2018) contention that emotional reactions mediate the relationship between technology use and well-being. Similarly, acknowledging students' emotional reactions in specific areas of technology use is vital for enhancing user engagement and improving learning (Demirkol et al., 2020). Positive emotions can signal motivation, engagement, and interest in learning.

The function of negative emotions may be more complex. On one hand, they may highlight cognitive difficulties hindering learning and motivation, but in principle, they may also be beneficial. Just as some stress is good for well-being, some negative emotional reactions may function, not as obstacles to learning but as incentives for learners to overcome difficulties. Emotional management during study is not yet a major focus of research, although with increasing attention in the humanities to self-governance (Heikkilä, & Lonka, 2006; Zhoc et al., 2018), this may change. In view of this, Mewburn's (2011) suggestion that social media use such as Twitter and blogging may aid in emotional self-regulation deserves further work. The finding that the range of social media use was positively related to current health is consistent with this suggestion and may reflect positive effects of social contact facilitated by different platforms during the pandemic. An alternative interpretation is that during the study period, healthier people were more active on social media.

On a further note, despite accelerated videoconferencing use during the pandemic (Ying et al., 2021; Del Rio-Chillcce et al., 2021), few respondents had received training in its use. With staff and students having faced unprecedented challenges in rapidly acquiring familiarity with new software, this is unsurprising. However, more specific training would undoubtedly help scholars to utilise its full functional capabilities and put it to optimal educational use. The availability of training and its take-up are relevant to how technology will be used and understood, both individually and throughout the scholarly community. One possibility, highlighted in the literature review, concerns assessment of incoming students' attitudes to technology (Olsen, 2020). Undertaken with sensitivity, this could help to identify areas of training that will benefit students.

It is now time to consider in further depth some key aspects of the survey analyses. These will discuss determinants of study progress, technology use and well-being, and communication.

7.2 Satisfaction with Study Progress

Satisfaction in study progress is of central importance in doctoral education, as it encompasses not just academic achievement but the overall doctoral experience, which includes dealing with workload demands, acquiring knowledge in one's study area, adjusting to technological tools, and remaining motivated and psychologically content. Many of these factors were reflected in the predictors of satisfaction.

Almost three-quarters of respondents were satisfied with their study progress, with several significant correlates of this identified. These were related to time management, perceived helpfulness of technology (notably videoconferencing and quantitative data analysis), preferences for digital over physical copies of information, finding software difficult to use or learn, emotional reactions accessing information sources (both positive and negative emotional reactions), health, perceived stress, and use of videoconferencing to communicate with other students.

A model utilising these variables accounted for approximately 26% of the variance in satisfaction with study progress. For the data collection period when pandemic restrictions were in place, the model explained considerably more - 39% of the variance. This is an important reminder of how factors may vary in their importance over time. Overall, two sets of variables were predictive - those relating directly to technology use (e.g., hours spent on computing devices on a typical day) and those concerning well-being (e.g., general health, stress, effects of the pandemic on study, effects of technology use on health). The findings lend weight to D'Angelo's (2018) contention that students' reactions and appraisals of technology use are likely to affect academic progress and are broadly consistent with the socio-technical model of human-technology interaction (Long, 2018), in which human factors are embedded in the operation of technical systems. The practical significance of these findings requires serious reflection.

In considering these factors, two issues merit attention. Firstly, that technology use and well-being may not be independent. For example, the pandemic is known to have had detrimental effects on well-being, through actual infection, perceived risk of infection and imposed social restrictions (Coelho et al., 2020; Singh & Singh, 2020). These direct effects on well-being might in turn influence how participants perceived and interacted with technology, as technology use came to assume new meanings. The influence of the pandemic on the results is striking. As stated, the model's predictive ability in the midst of the most severe period of the pandemic was much greater, with three variables (preference for digital over physical copies when reading, time spent online interfering with sleep, and effect of the pandemic on study) exerting a more pronounced effect in this period. These are consistent with students' greater reliance on technology during this time, with some perhaps finding difficulty in balancing study and private time at home; and can be thought of as specific cultural-technological adaptations to the pandemic. Several authors (e.g., Stewart et al., 2020) have by now pointed to the importance of time management skills in academic adaptation to the pandemic. In addition, patterns of technological engagement may also contribute to health and well-being. Modelling found that technology use and psychological reactions to technology use contributed around 15% of the variance in current health.

Secondly, given the cross-sectional nature of the study, caution is necessarily urged in interpreting correlational data in terms of causal relationships. For example, the observed relationships between satisfaction with study progress, and both stress and well-being can plausibly be interpreted in either direction, with both likely to be true. Consistent with the effect of well-being on performance, Storrie et al. (2010) found ability to manage emotional distress was a factor preventing academic dropout, while Grøtan et al. (2019) found students reporting high levels of mental distress were four times more likely to report low academic self-efficacy. In turn, poorer academic performance has been identified as a significant source of stress (Chawla & Sachdeva, 2018), with satisfaction with academic performance functioning as a protective factor against anxiety and depression (Pokhrel et al., 2020). With satisfaction with PhD progress appearing to involve an interplay between technical, and emotional aspects of study, the results support both the socio-technical and socio-cultural conceptual models discussed in earlier chapters (2 and 4) and are suggestive of potential areas where institutional support may be applied to improve the PhD experience. With these caveats in mind, both technology use and well-being will now be discussed further.

7.3 Technology

In examining the emotional and health correlates of doctoral satisfaction, the current study highlights digital technologies as contributing both positively and negatively to doctoral study.

7.3.1 Technology Use

Digital technologies are fundamental to contemporary doctoral study, with roles in supervision, access to research literature, analysis, peer support and communication.

Consistent with the contention that videoconferencing contributes positively to scholarly productivity (Rockinson-Szapkiw et al., 2014), raw correlations suggested videoconferencing (notably to communicate with other students) related to how respondents judged their progress. Given that the present study was conducted during the pandemic, this is significant. Since the pandemic's onset, videoconferencing has become a key tool in a restructured higher education system, enabling undergraduate and postgraduate education, communication with academic colleagues and research activity, such as conferences and data collection, to continue (Mobo, 2021; Khan & MacEachen, 2022).

The present study found technology use, in respect of instant messaging, videoconferencing and online data collection, differed between science and non-science students, with non-science students favouring these technologies more. These differences are grounded in the research processes in different disciplines, including non-science students' greater reliance on recruiting participants via technology. Furthermore, the nature of work undertaken e.g., laboratory work, interviews and surveys, the content of which is more formalised in the natural sciences, may encompass varying degrees of discussion, reflection and interpretation involving others, and can also be considered in relation to the pandemic's effects on the working practices of science and non-science students. Better understanding of the purposes for which technology is employed can be expected to clarify discipline specific issues in training needs. Although technological needs differ between science and non-science students, as Tsatsou (2017) proposes, and this study supports, current data give no indication that this has produced differences in satisfaction with study progress between science and non-science students.

Further differences in videoconferencing use were found, with markedly more women reporting it useful for data collection. This difference was independent of study discipline and requires explanation. It is plausible that issues of perceived personal safety, and time management in family life, may be responsible (Gray et al., 2020). The issue is considered further in subsequent interviews. What the above differences make clear is that specific technologies and their potential functions may be perceived and understood differently by different groups of students, depending on their own personal needs.

The decisions made regarding the forms of technology to use and when, and how this relates to academic aims, are likely to be driven by both formal and informal needs. How users acquire understanding of the technological possibilities at their disposal, and how this knowledge shapes decision making in both social and professional realms is presently not well understood. Viewing this process within a socio-technical framework (Baxter & Sommerville, 2011, Long, 2018) permits one to contrast technological functionality viewed through a purely 'objective lens', in which functionality is seen as fixed and residing within the technological product, with a wider view of functionality which emerges creatively through different users' capabilities, desires and interactions with technological systems. Though relatively under-explored, it is recognised that the cognitive complexity of software systems is a factor in users' understanding of their functionality (Wang, 2006). This functional aspect of participants' engagement with technology is something explored in the interviews. Below, the evaluation of technology in terms of its helpfulness is considered.

7.3.2 Helpfulness of Technology

Participants clearly found a wide variety of digital technologies helpful. Analysis indicated the perceived helpfulness of different software platforms could be grouped into several underlying factors, concerning academic communication, data analysis, data collection and interpretation, and information reception and storage. This structure has some affinity with Lawrenz et al.'s (2006) view that high school students perceived the helpfulness of technology in terms of two factors - its ability to function as an investigative tool, and as a means to further conceptual exploration. The utility of technology as an investigative tool is common to both studies. The more varied dimensions to helpfulness in the present discussion of quantitative data likely reflects technological developments since the earlier study, as well as the different nature of the cohorts studied, with doctoral students' primary orientation toward research work.

One possibility, which might explain the conceptual structure observed in this study, is that the different functions applications are designed to fulfil influence not only how they are learnt but also the efficacy and efficiency with which they are used. Confidence and proficiency on one platform can then be transferred to others with related structures and functions. Such adaptive learning (Morze et al., 2021) and interoperability across platforms may be driven by tacit acquisition of common problem-solving skills, as well as common attitudes and concepts underpinning software use. These may include a willingness to explore software functionality in the face of uncertainty. If so, confidence in using a range of applications could be instilled by identifying common functional elements across different platforms.

Further understanding of how students, strategically, cognitively, and emotionally, approach learning software at different stages of their careers is therefore needed, alongside whether learning data analysis concepts and applications early in one's postgraduate career has lasting consequences. How students acquire ICT skills, the barriers and opportunities they confront and the mental models they build of software remain poorly understood (Umar & Jalil, 2012; Batez, 2021) with no standard methodology for studying users' mental models (Anders et al., 2022). The importance of this may grow as users engage more frequently with what are more open-ended, creative software systems such as AI or imaging. Clarification of how users approach both closed and open-ended software systems could be of practical benefit in not only encouraging students' engagement with technology but also in developing training in how to use it. It is striking that the strongest predictor of whether students reported finding software difficult to use was feeling frustrated when accessing information sources.

What the above suggests is that the conceptual structure underpinning helpfulness of different forms of software, dealing as it does with functionality, may map onto general heuristic approaches to learning any software. In this picture, learning can be envisaged as a process affected by students' expectations of what particular software will enable them to accomplish, a process simultaneously cognitive and emotional, whereby the perceived helpfulness of software is related to the perceived difficulty of using it, which, in this study, was associated with stress and negative emotional reactions. This underlines the importance of students' psychological reactions to technology and the value of organising instruction and support that is sensitive to different students' needs and capable of mobilizing their learning resources (MacArthur, & Shneiderman, 1986; Rubens & Southward, 2020).

Much of the variance in participants' negative emotional reactions to technology use was predicted by a few factors –helpfulness of data analysis software (quantitative and qualitative), perceived stress, and absence of positive emotional states such as relaxation and engagement. Each of these requires further understanding. The findings highlight the centrality of data analysis in participants' emotional engagement with software, and the importance of the broader psychological environment. Instructors have long suspected that for some, prior adverse experiences in mathematics education affects learning in research methods and data analysis, and there is evidence, consistent with this, that mathematics anxiety contributes to perceived difficulty of quantitative research methods courses (Lin et al., 2016; Shamim & Akhtar, 2021).

The variance in the model predicting students' positive emotional reactions to technology use in this study was also driven by the helpfulness of software (for word processing and data collection), along with an absence of negative emotional reactions such as frustration, boredom, and anxiety. We can therefore see that different types of software may be conducive to negative or positive emotional reactions - gathering data with positive emotions and analysing it with negative emotions. All the findings thus far suggest the potential value of interventions directed toward the provision of psychological support, as Chang and Bryce (2020) advocate.

The experience of finding software difficult to use must also be considered in relation to the pandemic necessitating high levels of self-directed study. The data revealed that having received information from lecturers directly, face-to-face, was not associated with reporting less difficulty. However, the degree of such contact was unknown, with much direct contact compromised by enforced social distancing measures. The consequences of reduced face-to-face contact can be far-reaching. For example, students residing in relatively poorly resourced countries, where internet access may be beset by technical as well as financial issues, lack of face-to-face interaction and tuition is likely to be more disruptive to study than in technically well-resourced, richer countries (Adnan & Anwar, 2020; Gismalla et al., 2021). The result, several authors suggest, is that educational inequalities in many places have widened (Darmody et al., 2021; Perry et al., 2021). The social and communicative dimension to technology use is therefore important, extending beyond the utility of videoconferencing and the perceived satisfaction with, and helpfulness of, different technologies to their impact on educational equity.

7.4 Personal Well-Being

7.4.1 Emotional Relationship to Technology

Well-being is central to the experience of doctoral study. The analyses reported in the previous chapter suggest that doctoral students' health, well-being, and psychology exert a substantial influence on their evaluation of study progress, as well as their practical and psychological engagement with technology, in turn, affecting their well-being (Trockel et al., 2000; Gaultney, 2010; Eide & Showalter, 2012; Patrick et al., 2017; Wang et al., 2018). Several analyses point to the emotional significance of technology and support the contention that the 'emotional useability' of technology is as important as its practical ease of use (Shih & Liu, 2007; Saariluoma, 2020). Postgraduates engage with it, not as unemotional, dispassionate users, but as embodied, emotionally aware agents bringing their own affective and personal histories to their interactions with technological systems. Whilst research on the emotional terrain of technology remains limited (Novak et al., 2022) it has previously been described in terms of an opposition between frustration and competence (Saariluoma & Jokinen, 2014). The current work suggests it is more complex.

It is probable that positive emotions are enabled through successful completion of tasks in addition to the social connectedness present in many learning situations, whether remote and technologically mediated, or face-to-face. The extent to which positive emotions are contingent upon specific actors involved in a social exchange, as in psychotherapy, cannot presently be stated. Nevertheless, how much different software functions facilitate contact and communication with others, and the importance which is attached to this human connectedness remains of great interest. The present study's findings underline the importance of human connection in doctoral research, and its role in influencing appraisal of technology.

In the current political environment of higher education, the emotional relationship to technology may have additional significance. To date, perceived 'satisfaction' of undergraduate students with their course, as assessed in the UK (from 2005), by the National Student Survey has had far-reaching effects on the structure, content, and funding of university education. In parallel has grown a concern with student mental health, understood by policy makers and managers as a potential source of dissatisfaction and therefore a strategic priority to be addressed (Roberts, 2018). Whether a similar concern with postgraduate well-being will emerge and shape the postgraduate environment remains to be seen.

Acknowledging technology users as emotional actors with strengths and vulnerabilities has implications for how the meanings of technology are socially constructed and what meanings are prevalent amongst users (Burr, 2024). These meanings have implications for how technology training is approached and what it intends to achieve. Training in technological skills may be considered as a means to aid study, and the more widely available and accessible the training, the greater the presumed benefits. Training, of necessity, should not be confined to those already comfortable with technology, who may readily seek it out. Those more embarrassed or reticent to seek out training arguably have more to gain from it.

Institutional surveys conducted at enrolment can be one way of ascertaining students' needs and could inform how institutional provision might best proceed. Recommendations to be made from the present study (Chapter 10), together with work by Adeleke and Nwalo (2017) provide examples of how assessments could be designed, organised, and implemented.

7.4.2 Training and Support

In suggesting learning technological skills requires attention to emotional aspects of scholarly life, one can ask whether training is best organised individually or on a group basis. Meschitti (2019) favours the latter, with skill acquisition undertaken in peer groups. Panayidou and Priest (2021) found that participation in groups offering emotional support to PhD students was effective in reducing anxiety, stress, and risk of dropping out. The authors, who ran weekly peer groups over a two-year period, believe they can form an integral part of the training and support offered to postgraduates, with such support linked to academic success (Akoji et al., 2019).

The identification of perceived stress as a determinant of satisfaction with study progress also has implications for what kind of support could be offered to doctoral students. Mental health pressures facing undergraduates are recognised (Jessop et al., 2020; Frankham et al., 2020), along with need for effective stress management programs (Kassymova et al., 2018; Winzer et al., 2018; Amanvermez et al., 2023). The present work adds weight to the argument that postgraduate support is equally important. An added benefit of group-based interventions to nurture postgraduates' well-being, is that they may also contribute to social connectedness and integration (Chang & Bryan, 2020), thereby enhancing the social cohesion of the scholarly community (Berry, 2017).

Prior to delivery of group level support, initial surveys could assess existing attitudes to technology, including apprehension toward its use, and the confidence with which it is approached (Castles, 2004). Negative attitudes are likely to impede vital skill acquisition and disadvantage students. Acknowledging difficulties some postgraduates face, Khasawneh (2022) claimed that with the right resources and support, technology acceptance can be improved. 'Technophobia' remains a problem in higher education (Al-Maroof et al., 2020), though how this is affected by online delivery is yet to be addressed (Khasawneh, 2022). In the current study a significant minority reported difficulty in using and learning software, with evidence that this reduced engagement with technology, its perceived helpfulness, and study progress. This difficulty was also linked to poorer health, stress, and negative emotional reactions, particularly frustration, when accessing information sources (Saariluoma & Jokinen, 2014). Identifying students with specific technology needs, instituting relevant training, and providing emotional support, thus, are viable goals for improving postgraduate life and study.

7.4.3 Time Management, Well-Being and Study Progress

In contemplating postgraduate engagement with technology, one must consider the specific technology used, how it is used and appraised, and the consequences of its use, including its relation to study progress, health, and well-being. Given this complexity, technology use may offer both benefits and drawbacks. For example, it may assist students in allocating time, effort and resources to further their academic, intellectual, occupational, or social goals, but also foster problematic internet use or stress. The data pointed to difficulties in time management affecting individual and social well-being. The survey documented the disruptive potential of internet use and despite the limitations of cross-sectional data, suggested time management issues associated with technology use affect study progress, health and well-being. Over three-quarters of respondents thought they spent more time on the Internet than intended, and almost half pointed to online activity affecting sleep patterns and social life, and two-thirds to problems exercising. These reported problems were correlated with measures of self-reported health and stress.

It is credible to suppose that stress and time management exert reciprocal effects (Maqableh, & Alia, 2021). Stress may deplete cognitive and emotional resources and engender less efficient use of time, which in turn may lead to frustration and anxiety (Abdous, 2019), as data here suggest. However, time online may also provide an escape valve or 'digital distraction' from existing stresses (Cheng et al., 2020; Pérez-Juárez et al., 2022), including stress generated whilst studying (Bennett & Folley, 2014). This adaptive potential of online time management and its capacity to increase work satisfaction (Chan et al., 2005) as well as study progress (Kitsantas et al., 2008; Khanam et al., 2017) needs consideration when designing interventions for postgraduates.

The observed correlation between perceived stress and satisfaction with time management concurs with findings from Nonis et al. (1998), Nonis and Hudson (2010) and Alhasani et al. (2022), with the latter reporting that individual preferences for organisation underpinned a sense of perceived control over time which mitigated students' feelings of stress and anxiety. Alhasani et al. also found that the relationships between perceived control over time with perceived stress and preference for organisation were stronger in graduate students than in undergraduates. It was also graduate students who reported greater pandemic anxiety. The authors reasoned that desire for greater control acted as a coping mechanism in the face of uncertainty precipitated by the pandemic. As the pandemic pushed people online, two contrasting effects appear to have been operative. On one hand, it contributed to a sense of organisation and control as daily routines were curtailed, on the other, due to its potentially compulsive nature, time online, for some, may have weakened the sense of control which functions to cope with pandemic generated anxiety. A delicate balancing act is thus required.

Balancing competing demands of work, study, leisure, and home life, via strategic planning and preparation (e.g., for reading, writing, contemplation and discussion) in a manner which fosters self-efficacy, confidence, and control, leading to productive work, is a neglected skill and its lack may be a factor in students' withdrawal from study (Castello et al., 2017). It remains a skill seldom taught in higher education and one to which training might usefully be applied.

In this study, spending more time on the Internet than intended accounted for a small though significant proportion of the variance in happiness with time management. The explained variance was increased by the addition of specific problems linked to time on the Internet. However, most of the variance in happiness with time management remained unexplained. In considering these findings, one must remember that the statistical models employed assessed main effects only, and not potential interactions between the different disruptive effects (e.g., on sleep, exercise, social life etc.). It is plausible that the effects of these are multiplicative and could raise the explained variance, in addition to unconsidered factors at play. This aside, it is likely that unhappiness with time management cannot be entirely explained by factors connected with technology use. External demands associated with respondents' wider personal and study circumstances are undoubtedly relevant, alongside differences in the degree of control experienced in the workplace (Villarreal-Zegarra et al., 2022) and individual preferences for organisation (Gruenfeld & Tiedens, 2010).

Time management itself may be considered in two ways. First, in terms of the actual amount of time spent interacting with technology and second, how productively that time is used. Both may influence academic achievement. Several studies have linked effective time management to academic attainment (e.g., MacCann et al., 2012; Alsalem et al., 2017; Richiţeanu-Năstase et al., 2018; Nayak, 2019; Watanabe et al., 2021) with suggestions that it may also reduce anxiety (Adams & Blair, 2019). The present observation that satisfaction with time management and satisfaction with study progress were positively correlated is consistent with these.

Time management can be considered to affect academic performance through two potential pathways (Fig 7.1). One concerns a direct effect on academic practice – how much time is allocated to reading, writing, contemplation, and planning and how well this time is exploited. The second pathway is indirect, with effects of time management on study progress mediated by health and well-being.

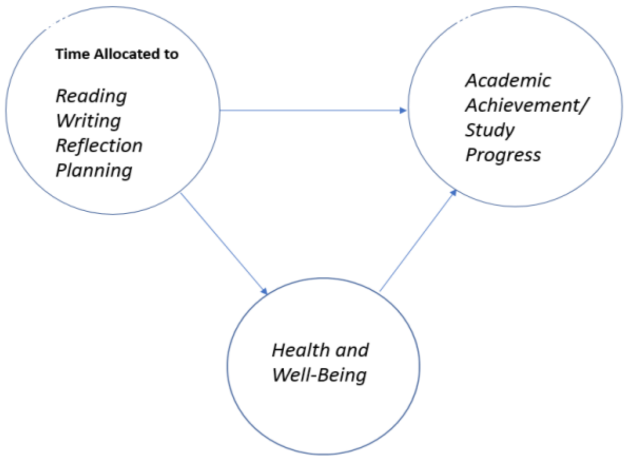


Figure 7.1 Effects of Time Management on Study Progress.

These pathways encompass Macan et al.’s (1990) consideration of the perceived control of time and its relationship to student evaluations of performance, work, and life satisfaction. Regarding indirect effects, data from this study found that lower satisfaction with time management was correlated with perceived detriments to sleep quality, exercise, social and family life, consistent with a mediation effect. However, regression analyses suggested that these detriments could not explain the observed relationship between satisfaction with time management and satisfaction with study progress, lending no support to the mediational model.

7.4.4 Technology Addiction

Further understanding is needed of multiple aspects of time management and precisely how these impinge on academic practice and well-being. This issue is explored further in the interview phase. Whether these observed effects (on sleep, exercise, social & family life) exhaust the negative effects of time spent on the Internet can be questioned. When asked about problems experienced with technology, several raised the issue of addiction to technology. This is consistent with evidence that students (Simsek et al., 2019), and the general population (Ashford et al., 2018; Oprea et al., 2021; Sherer & Levounis, 2022), exhibit signs of what can be considered technology addiction. While the cognitive components of problematic internet use are incompletely understood (Lopez-Fernandez et al., 2022), this addictive quality, it has been argued, stems from its potential to deliver rapid short-term rewards at the click of a mouse or swipe of the screen (Kazmi et al.,2025). Savci and Aysan (2017) discussed four ways in which this can manifest; internet addiction, as well as social media addiction, digital game addiction and smartphone addiction. All of these have been associated with poorer psychological well-being. Currently, the concept of internet addiction, as a behavioural problem akin to gambling, remains contested (Pontes et al., 2022). Nevertheless, studies in diverse populations have provided varying estimates of its prevalence. A cross-sectional survey of 6,000 young adults (aged 18-25) in the US put the prevalence of problematic internet use at 53.6%, with 24.3% beset by gaming addiction and 3.4%, social media addiction (Moreno et al., 2022). This is substantially higher than the 33% found with Iranian students (Salarvand et al., 2022), and the 30% reported in a meta-analysis of Chinese medical students (Zhang et al., 2018). Even greater estimates, above 70%, have been found with both Vietnamese (Thi & Trâm, 2020) and Iraqi students (Sgery et al., 2021).

The different populations studied and lack of standardisation in addiction criteria used make strict comparison between studies difficult. Research into technology addiction is hampered by the fact that no consensus exists on how to define it, nor how to best assess internet use. Baggio et al. (2017) contend measures which combine both quantity and frequency of use may be more reliable, as well as being predictive of well-being. Kesici and Tunc (2018) proposed six criteria when examining internet addiction: salience, mood modification, tolerance, withdrawal, conflict, and relapse. These are orientated toward psychological and psycho-physical reactions to internet use and incorporate aspects of what can be termed 'mood management' (Khan & Hammami, 2019). These authors also suggested culture should be considered alongside time management as an important influence on potential addiction. Most studies, however, have adopted a narrower view, with many of these dimensions escaping scrutiny. As a result, how each of them affects academic performance, singly or in combination is unknown. These difficulties notwithstanding, Zhang et al. (2018) suggested the prevalence of internet addiction increases with educational level. Given the nature and extent of technology use in higher education this should not be considered surprising.

While technology addiction may plausibly contribute to how satisfaction with time management influences satisfaction with study progress, the present study found no evidence that the range of social media use was related to study progress. However, as the number of platforms used may not reliably indicate the amount of time spent on each of them to the detriment of work-related activity, this finding cannot be considered conclusive. The relationship between technology use and well-being has taken on added importance since the pandemic, the impact of which has been felt on both. This will now be discussed.

7.4.5 Personal Well-Being: The Pandemic

The data confirmed the overall negative impact of the pandemic on well-being. The educational challenges from the pandemic have been considerable, with unprecedented demands on staff and students (Turnbull et al., 2021). As the pandemic-induced disruption subsided, forms of technological activity introduced during it, such as emergency remote teaching (ERT) (Rapanta et al., 2021), have undoubtedly contributed to what is now a substantially changed post-pandemic higher education environment.

A report from the UK (BBC News Online, 2023) in which 50 universities were surveyed depicts a radically changed landscape. The investigation revealed that over one quarter of courses (28%) were delivered in a hybrid fashion compared to fewer than one in twenty (4.1%), pre-pandemic. That much educational delivery has continued online, when there is no longer a pressing need for it, probably disadvantages students (Oh, 2021; Hidalgo-Camacho et al., 2021) for whom the ability to self-regulate and self-motivate in the face of relative social isolation, in both academia (from peers and faculty) and personal life, is challenging (Zgheib et al., 2021). In this shift to online delivery, there is little evidence that student well-being has been prioritised or that the quality of education delivered has been considered the equal of face-to-face learning (Orhan & Beyhan, 2020), although university investment in distance education has undoubtedly been one consideration (Ashour et al., 2021). The limited data available suggests student preferences during the pandemic were for online, real-time lectures, alongside available recordings (Yatigammana & Wijayarathna, 2021). What many received were text-based online material or presentation slides, which have not proven popular (Egielewa et al., 2022).

It is unsurprising that in the present study, many more respondents viewed the pandemic as having negative rather than positive consequences for their studies. This concurs with studies reporting severe mental health issues in university populations following the pandemic (e.g., Son et al., 2020; Cao et al. 2020; Copeland et al., 2021; Quintiliani at al., 2022), with closures and stay at home restrictions correlated with depressive symptomology (Buffel et al., 2022). How long such detrimental influences may persist is difficult to discern. Whether the impact on students will be equally felt is of interest. In a survey of over 3,000 medical students in the Philippines, a large majority (86%) reported psychological difficulty in adapting to online education, with previous experience of online learning, age, gender and socio-economic status, factors in how students responded (Baticulon et al., 2021).

Five challenges have been identified in delivering online education: self-regulation, technological competency, technological sufficiency, technological complexity, and student isolation (Rasheed et al., 2020). Each of these was exacerbated by the pandemic. For example, studies of Russian students found lack of technical readiness (Salakhova et al., 2022), lack of engagement and decreased motivation compounded problems faced during the pandemic (Frolova et al., 2021). Students are not alone in having faced such difficulties, with many workers outside academia also finding home working during the pandemic less productive (Rubin et al., 2020).

Some evidence suggests the relative absence of face-to-face contact and ensuing social isolation from lockdowns adversely affected mood, vitality, and motivation (Zaccoletti et al., 2020) and made research activities more practically difficult. What the longer-term consequences of this will be is unclear. Further in-depth interviews address how the pandemic has been experienced by participants in the current study.

Use of videoconferencing during the pandemic has necessitated emotional and motivational engagement from students different to anything previously encountered, and in the absence of formal training. Maintaining well-being during the pandemic has also been driven by non-technological factors. For example, student involvement in curricular and extracurricular activities (Plakhotnik et al., 2021). In a somewhat different vein, Canale et al. (2022) discuss how technology may have contributed positively to mental health during the pandemic, emphasising its role in facilitating the online expression of emotions and social support. Further understanding of the psychological consequences is relevant not only in the aftermath of the pandemic but also with respect to the social organisation of academic life in potential future pandemics.

In summary, the present study shows technology is an important influence on postgraduate well-being. Perceived stress, financial difficulties, helpfulness of technology and people's emotional reactions to it, were all determinants of well-being. Undoubtedly, videoconferencing helped bind the academic community together, at a time when its social and interpersonal character was vulnerable, a function described by some as akin to "rescuing education" in a time of crisis (Adipat, 2021). Overall, the findings on well-being, particularly during the pandemic, have important implications for how universities organise and support doctoral education.

7.5 Communication

This section concerns doctoral students' experience of research communication and the digital technologies which mediate interactions with supervisors, peers, and the wider academic community. Data suggested the available avenues for postgraduate communication with both students and staff, via videoconferencing, email etc. formed an important backdrop to how participants evaluated technology use, their perceived difficulty in using it, the uses to which it is put, and the consequences of that use.

Although the effect sizes observed are small to moderate, they are of practical importance, not least in the implications which videoconferencing with other students has for study progress. The data are consistent with work showing ‘peer learning’ can influence learning and academic attainment (Smith et al., 2018; Lim et al., 2020; Cheung et al., 2023). How communication with other students differs from that with staff needs further exploration if we are to better understand how peer-to-peer videoconferencing aids study progress.

Digital communication occupies a central place in academic life and has radically transformed it. Before the pandemic, most peer learning would occur in physical settings. These communication spaces typically comprise multiple actors in close physical proximity. Whether the richness and non-verbal complexity of face-to-face settings can be duplicated virtually is currently unknown, though it is likely some loss of emotional information, usually conveyed by unconscious bodily signalling, will occur (Cataldo et al., 2021). This may be for good or ill, as aspects of negative emotional communication may also be attenuated by digital media or subject to social expectancy effects which reduce them, distinct from positive effects of perceived social support (Gabbiadini et al., 2020). Identifying precisely the beneficial aspects of communication, both virtually and face-to-face, may enable these to be cultivated with greater efficacy. The interview findings to follow cast light on this.

Owing to the pandemic, virtual communication will have assumed varying importance over the duration of data collection, hence understanding the broader situational parameters which govern its effects, including how it shapes communicational content and academic performance is vital. For example, the pastoral content of exchanges, in addition to academic instruction, discussion and information sharing, may raise students’ motivation and improve the confidence and persistence with which they approach study (Price et al., 2007; Pyhältö et al., 2012; Spears & Green, 2022). Exchanges between parties, whether pastoral or pedagogical, will be subject to the technical, communicational, and social competencies of those involved (Grammens et al., 2022). As the digital world evolves, the nature of these competencies can be expected to evolve with it.

7.6 Conclusions

The survey findings highlight the complex and ambivalent nature of doctoral students' relationships with technology. Considerable variability in patterns of use, appraisal, and reactions to different technologies were evident, though few systematic demographic differences were observed.

A range of technological benefits were reported, including accessing and gathering information, data analysis and communication. Additionally, a few participants acknowledged the potential of technology to provide entertainment though it was not possible to ascertain any relationship this had with academic practice. Unsurprisingly, given the survey's context, most of the reported benefits bear directly upon academic life and appear to have played an important role during the pandemic. As discussed, respondents drew attention to a range of potential and actual problems arising from technology use and which have relevance to their studies. These included little formal training, difficulties in using and learning specific technologies, difficulties in managing and controlling time on the Internet, potential technology addiction and distraction, lack of human contact with online delivery, and problems with stress and health. A notable finding is that respondents' interactions with technology are characterised by levels of emotional engagement, both positive and negative, which appear to have consequences for their studies. These findings point to technology as tools of empowerment and sources of friction for doctoral students and have implications for how universities provide support and training.

Evidence was presented that a range of factors influenced how respondents evaluated their study progress. These were grouped into those directly related to technology use (e.g., time spent on computing devices) and those pertaining to well-being (e.g., perceived stress). Together, these explained over 25% of the variance, with enhanced predictive ability during the period when the pandemic was more disruptive.

Further analysis established that finding software difficult to learn or use, could, like study progress, be similarly predicted and was related to students' negative emotional reactions, notably frustration, when engaging with information sources. In conclusion, the analyses highlight inter-relationships between technology use, health, well-being, and emotion, all of which influence how respondents perceive their study progress. These relationships are situated in a technological eco-system shaped by tools largely provided by major technology companies and a biopsychosocial climate shaped by the COVID-19 pandemic and its aftermath.

7.7 Limitations

Although the findings provide useful insights into doctoral students' engagement with digital technologies, there are important limitations which must be acknowledged. In evaluating the findings from the survey, appreciation of the pandemic context is imperative and underscores how engagement with, and evaluation of, technology are bound to a given social and historical context, with appreciation that the present period of technological change is perhaps unprecedented (Mohammed, 2019).

Perceived study progress, like all the measures which have been employed, is a subjective one. However, in the absence of agreed concrete benchmarks to evaluate attainment prior to thesis completion, it can be considered an appropriate indicator of how students are progressing. Such self-assessments of academic progress have previously been employed in postgraduate populations, when researching the relationships academic performance has with ethnicity (Woolf et al., 2011) and mental health (Grøtan et al., 2019). Self-report data are widely used in surveys. The current single item measures which assessed health and well-being, whilst subject to potential recall bias, and mood are frequently employed and accepted as having both good reliability and the ability to predict mortality, morbidity and healthcare utilisation (Atroszko et al., 2015; Smith et al., 2024). With respect to assessment of emotional responses, these are inherently subjective, with self-reports being the only practical means for data gathering.

It cannot be overlooked that the present study is cross-sectional and hence evaluation of potential cause and effect relationships must be treated with caution. Some of the hypothesised effects here therefore must await longitudinal studies for confirmation. It can be noted that amongst those who began the survey, item completion was high, suggesting that non-response bias, if present, is low. Nevertheless, a potential limitation concerns the representation of specific sub-groups (e.g. part-time and international students) within the population of doctoral students, and which may limit the analyses which can be performed.

7.8 From Survey to Interview

The survey data at best point to relationships between variables but by themselves can cast little light on the underlying meanings which sustain them. The main aim of the interviews therefore is to illuminate processes of meaning making which underpin these findings and which pervade doctoral students' technological engagement, with the added aim of considering their implications for well-being, academic success, and quality of education. As such the qualitative phase of the study provides an important 'correction' to the restrictions of closed survey items.

In particular, the interviews permit exploration in greater depth of several of the issues which arose in interpreting the survey data; the relationship of time management to academic practice and well-being, emotional reactions to technology, beneficial aspects to virtual and real-world communication, the role of videoconferencing in relation to perceived personal safety and time management, effects of the pandemic on study, and how issues of technological complexity/functionality are experienced. The next chapter discusses the outcomes of the interviews. Together, the two phases provide a more complete picture than either alone of how technology functions in doctoral study.

Chapter 8: Phase 2 - Interview Results

This chapter presents a set of constructed themes developed through reflexive thematic analysis, which offer informed interpretations of how doctoral students make sense of digitally mediated doctoral study. The analysis of the interviews yielded five major themes (Figure 8.1). Arguably, the most salient of these concerned how the pandemic *induced a cultural shift in technology use.* This can be considered an overarching theme which constitutes the situational/contextual backdrop against which all other identified themes emerged, as well as highlighting the period, and its immediate aftermath, in which the present study was conducted.

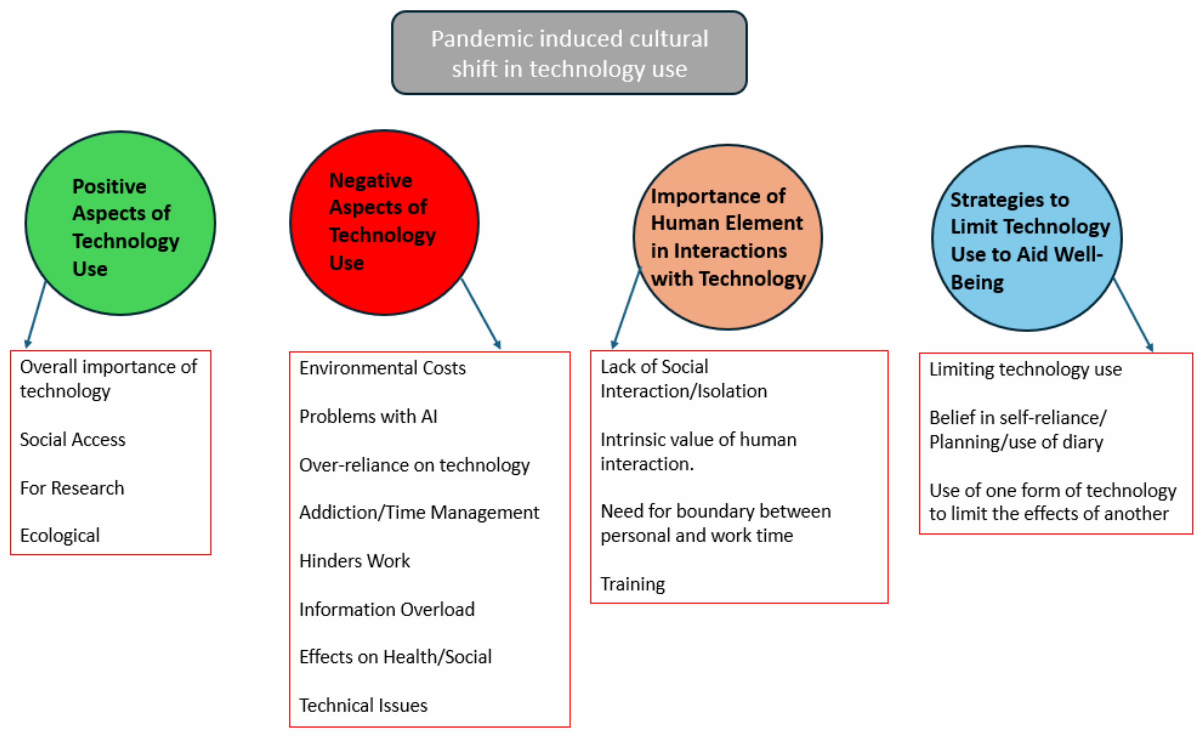


Figure 8.1. *Schematic Representation of the Thematic Analysis*

Three themes can be considered to reference doctoral students' own evaluations of their technological ecosystem, covering respectively *positive aspects of technology use*, *negative aspects of technology use*, and the *importance of the human element in interactions with technology*. The final theme concerns the active *strategies* which respondents discussed employing *to aid their well-being when engaged with technology*. Beyond the contextual basis of the pandemic, each member of the subsequent thematic quartet comes with a set of distinct sub-themes which qualify the character of its parent theme. Evidence for the five themes, with their associated sub-themes, are presented next.

8.1 Pandemic-Induced Cultural Shift in Technology Use

While the survey revealed widespread use of videoconferencing, and other digital tools during COVID-19, the interviews provided a more detailed picture of how participants had been affected by the change. Mention of and allusions to the pandemic, and its effects, and how this shaped both technology use and its evaluation were a recurring feature of many interviews. Christabel for example, referred to the enormous change induced by COVID.

> *"I think that that, like the COVID, has completely changed to the way a lot of people work, like a lot of people work from home now and when they didn't previously. So, it would think it was extreme then, but it has had like a knock-on effect even now…We went from a fully face to face, frontal kind of lecture to all of a sudden not having it." (Christabel, lines 420-412; 1114-1117)*

Samantha spoke repeatedly of the pandemic's rapid onset and how this had led to a sudden shift in the mode of working. For her this was an enormous transition.

> *"So the work culture is ... now you're empowered to, to have a part of the work always on your personal device as well. So you have always your mail, your video conferencing, that it could be either teams, Google Meets or any of that or Zoom as well...more than 15 years of consecutive studying on pen and paper, and all of a sudden, I'm using this new device… everybody had to start using these devices." (Samantha, lines 37-40, 259-60)*

She summed up this transformation by declaring that the pandemic had:

> *"...affected my study by completely turning it inside out. There were a lot of things that needed to be changed." (Samantha, line 1130)*

This was a period of tremendous uncertainty, which led to increasing screen time:

> *"We didn't know back then how long it was going to last… while at the beginning I was just looking at a screen when I was at home, then it became I was home the whole time, and all my lectures were done through that. So I started looking at a screen for the better part of a day." (Samantha, 1131-1132, 1139-1141)*

Harold similarly commented on how the effects of the pandemic had been widespread, reaching into diverse aspects of one's existence.

> *"It affected…everything was online. So, the technology played like an important role…like doing everything, basically even meeting with other, even friends, you know." (Harold, lines 750-752)*

Just as Christabel, Samantha and Harold felt catapulted into a world of change, Emir, too, felt the pandemic had precipitated a major transformation in the nature of his work.

> *"I did most of my PhD during the COVID time…it affected [me] considerably. I had to change my whole methodology of the PhD." (Emir, lines 821, 1316)*

Fortunately, this change was regarded as “manageable,” although still “stressful.” The consequence for Emir was that because of COVID, he now

> *“…had no [direct] accessibility to any people.” (Emir, lines 89-90)*

In these new circumstances, the original functional purpose of the technology he used had shifted. It now became the necessary means for maintaining academic contact with others.

> *“So, like these online meetings, technology helped me to communicate with my supervisors.” (Emir, line 96-97)*

This sentiment was shared by several participants. Slaveia spoke of how the “collaboration and discussion of papers” with colleagues, enabled by communication technology, was “extremely important.” She went on to say that without it,

> *“I don't think we [would have been] able to have that much collaboration and discussion of papers, studies and topics in general…because we, after COVID…we stopped meeting that much in the office.” (Slaveia, lines 725-727)*

The major effect of COVID on students was contingent on the obligatory lockdowns that were instituted by government. In the midst of the isolation, consequent to this, Sheila spoke of how videoconferencing had offered a lifeline:

> *“I've been very grateful, I had an opportunity to keep in touch with them during COVID, so I was kind of happy of being able to see another face through a video call and talk with someone while being isolated.” (Sheila, lines 656-658)*

Yet despite this technological salvation, there were aspects of the reduced social contact that technology could not so readily ameliorate. While Sheila was grateful for the benefits of the technology, she judged the quality of online meetings detrimentally when compared to prior face-to-face ones.

> *“They were not very productive, as the ones that we had face to face… It wasn't a good experience, but it was better because you were not feeling very isolated, and you could still ask any questions that you had.” (Sheila, line 1906, 1913-1924).*

In addition, she lamented the effects of all the technologically mediated training.

> *“I think it would be more helpful if it was face-to-face, if it was in person, but because it was like we had the COVID, it was very difficult for it to happen face to face.” (Sheila, lines 596-597*

The effects of the pandemic, moreover, had unintended effects, extending beyond the technological maintenance of social ties. Samantha spoke of how the necessary recourse to videoconferencing had blurred the lines between what constituted ordinary human connection and that which was quintessentially mediated by technology:

> *"…after COVID, especially when everything was just through, through a device, it became a bit harder…The problem with everything is that when there are blurred lines, then you know, things starts matching, like mixing and blending in with each other." (Samantha, lines 3007-3011)*

By this she perhaps meant that the ensuing saturation of mediated communication affected the quality of relationships between friends, now *only* reachable through technology, such, that this was not so easily distinguished from the 'relationships' which evolved with the plethora of personalities and social influencers who regularly inhabited one's own enclave in cyber space.

> *"So even this kind of … relationships that we start, that people started having, with, with other people, like influencers or people that stream online. You know, are you following someone because you like the content, or it's because you want to interact with them and you refer to them as, as another relative, slash friend? Because I don't think that there is such thing, you know, like, I don't think you're actually befriending someone that is…followed by a million people." (Samantha, lines 3007-3023)*

This blurring of boundaries between the space for customary face-to-face interactions and that for online interactions marks a profound shift in the mode of subjectivity induced by the pandemic, and this was not the only area where old distinctions were disrupted by the rapidity of the switch to online working. Harold, for example, found this opened the door to frequent distraction:

> *"I got distracted quite often, because I am normally used to have like things in paper or in books." (Harold, lines 206-207)*

He went on to say that in order to maintain clear boundaries and reduce the time devoted to reading on screen, he would

> *"…even today, when I have to study something, or I want… I try to print it or to have it like a, like a hard copy." (Harold, lines 213-214)*

This could be considered an attempt to maintain what was a preferred way of working with the written word, one that was retreating into history, even while he recognised the importance of technology at this time.

We can see from the above that for participants, technologies which had previously been optional (e.g., videoconferencing, virtual meetings, online lectures) became established, with a corresponding shift in community practices. We can also see that recognition of the shift in working life created by the pandemic, and the pre-eminent role of technology in this (Watermeyer et al., 2021) were subject to constant evaluation. The outcomes of this, whether for good or ill, are discussed in the next two themes.

8.2 Positive Aspects of Technology Use

The participants communicated many positive effects of technology use and viewed it as an integral part of their doctoral experience. The first of the sub-themes detailing these positive aspects concerns their overall importance – seen by many as the backbone of their work.

8.2.1 Overall Importance of Technology

As indicated, Harold referred to the crucial role played by technology during the pandemic. One aspect of its importance for him, which he was eager to stress, concerned his need to have access to the most up to date technology for his work.

> *"For me is, like, really, really, important to have like the like technology and have everything updated…And I we normally use like a state of art instruments, because at the end, you want every day, well, not every day, but every year they have new launches. They have better instruments and better software…So that's, for me, it's, like, really important to have this technology around…" (Harold, lines 53-59)*

Consistent with this, his appraisal was in large part driven by an instrumental assessment:

> *"It helps you to do things quicker and to improve results." (Harold, lines 119-120)*

He spoke similarly of the significance of communication technology:

> *"For me, it's like, very important. Yes." (Harold, line 636)*

Sheila was succinct in her own general appraisal.

> *"Technology makes my life easier." (Sheila, line 206)*

Several respondents, taking a less instrumental line, struggled to contain their enthusiasm, as can be seen from the extracts below. Maya's appreciation of the value of technology extended beyond work and study to embrace its ostensible contribution to helping us improve as human beings.

> *"I just think that technology is a really, really, great thing that helps us improve as human being in everything in our communications, in our work, in our study. And it's very, important for us as researchers!" (Maya, lines 2129-2132)*

In a further comment she expressed her hope and perhaps a deep faith that the forward march of technology would continue unabated:

> *"it's very important and I hope there will be more technologies in the future to help us as well." (Maya, lines 2145-2146).*

Deirdre, who was studying the role of "everyday music" in relation to psychological well-being was unabashed in expressing her happiness with the technological instruments at her disposal. For her, they were fundamental to her work and an evident source of satisfaction.

> *"I love technology" (Deirdre, lines 22)*

Later in the interview, she sought to explain at greater length her appreciation for the tools she used in her work:

> *"I've used lots of music technology… and I've used lots of platforms like YouTube, and that's been really important in my work. I produce lots of videos and music using Vimeo and using not Vimeo. What am I thinking of Audacity and having a look here Filmora.* I've used quite a lot of Filmora in my producing stuff for parents… for sure. I love technology." (Deirdre, lines 1187-1196))*

* A video editing tool.

8.2.2 Social Access

Practically all participants spoke of how videoconferencing and applications such as WhatsApp allowed them to easily keep in touch with, not only academic staff but also family and friends who were physically distant. The following are typical of the remarks made:

> *I use Zoom and Teams… to meet with my supervisors, to meet with friends, to stay in contact with maybe other PhD students I have left now and at different universities, I also sometimes use Zoom to…meet with friends from my home country." (Nicola, lines, 27, 617-620)*

> *"These online meetings, technology helped me to communicate with my supervisors… at the beginning of my supervision meetings, I used to record my meetings… It was easy. It was online, so I asked them if I can record, and they both said, Okay." (Emir, lines 96-97, 1075-1077)*

> *"I'm glad that I can keep in contact with my colleagues and my course mates about things. It's easier to work in groups and do group work even if we are far away from each other. And it's fast. You know, you can call someone now and they will answer, and you can have a meeting within an hour." (Sheila, lines 688-690)"*

Furthermore, several explicitly referenced the benefits to their family life which technology afforded. These comments by Neville and Zoe were fairly typical:

> *"I probably don't see any difference, but in positively contributing to my family life, I think that the videoconferencing software allows me to be more present in the house and with that extra time, I can dedicate that to being more present to whoever I'm living with." (Neville, lines 598-601)*

> *"and then contributing positively to family life. It means that video call my family, because everyone's got a phone, everyone's got a tablet. Yeah, everyone's on social media." (Zoe, lines 395-396)*

This access and contribution to social, family and professional life, facilitated through virtual spaces extended to participant recruitment for the students' own research. Wei, a Chinese student, used 'WeChat' during his research and referred to the speed with which research participants could be recruited.

> *"All Chinese people use it…And also we have a group chat in our accommodation. So you know is when I recruit my participants. That helped a lot…. I want to recruit as more participants as I want. I just use this way it will accelerate your speed for participants recruiting." (Wei, lines 1811-1814, 1887-1888)*

Another respondent, Christabel, highlighted the positive role of technology for her, as a person with dyslexia, in being able to access, and benefit from higher education.

> *"I record, especially if it's for the research…all of the videoconferencing. I don't do it with my supervision meetings. I just take notes for them. But if, if there were lessons or anything, I would use the recordings…I have dyslexia, so sometimes it helps for like, if I've written notes, they don't explain it as well. So, if I kind of need to, like, hear somebody explain it fully, then having the recording is really helpful." (Christabel, lines 379-383)*

The assistance provided to neurodivergent students illustrates how technology can take on functions not anticipated in their original development. This was also evident with Natasha, an autistic student, who was conducting research in physics. She explained some of her difficulties and why she preferred technology mediated interaction to that occurring face-to-face.

> *"I still will struggle a bit with the executive functioning thing just because…I have like autism… I don't go onto campus as often as others, just because it can be a bit overwhelming… [I prefer] um technology, because it gives you more time to think…because you can, if it's all online, you can kind of do things in your own time and reply well within reason." (Natasha, lines 1250-1251, 1311-1312, 1046, 1059-1060)*

In a similar vein, Alexandra commented on the flexibility which online study offered to non-traditional students. There were many different aspects to this:

> *"When you think about people who have a families, so if they're a non-traditional student, and they might have caring responsibilities, or they might live in a rural area where it's not possible to travel, and maybe they live on an island, and they're bringing a lot of value…an important part of their study is maybe working in their village, but it's just not feasible to travel to the physical location of a university regularly to complete their studies, and so, allowing them to remain in their community, can make it possible for people to attend university who otherwise wouldn't." (Alexandra, lines 1036-1042)*

As well as the benefits to neurodivergent and 'non-traditional' students, technology was seen to also offer something of considerable import to a sizeable group of other students. The ability to attend meetings and to work from home reduced the need for travel and by doing so enhanced the safety of students in at least two ways. The first, explained by Alexandra, an epidemiologist, concerned reducing potential exposure to COVID-19.

> *"When the pandemic started, I was on the first incident management team…in the United States…So I actually went from being home based to working at my duty station again. But it made it possible for me to…teach from the lab and …from our offices so that I could continue working on my regular job and keep my students safe at home. And a lot of my students were nursing students, and they had like, clinical practicals that they were doing, and I didn't want them mixing more than they needed to, and I definitely didn't want to be mixing with them." (Alexandra, lines 931-938)*

The second means by which technology contributed to enhancing students' physical safety was also linked to the reduced need to travel, but as Zoe (below) explained, this dimension of safety was not related to the threat of exposure to infection but to physical violence.

> *"Um, I think personal safety because I don't have to travel. Means I don't get lost on trains. I don't have to worry about, like, being in a really big city, and because that's where we see a lot of like, attacks on people happening, not have to worry about that." (Zoe, lines 387-389)*

With increasing reports of violence and harassment of women on campus (Universities UK, 2016; Bovill et al., 2022), it may not be accidental that the issue of potential physical safety was raised by a female student (see also Gray 2020).

8.2.3 Research Support

As the sample comprises doctoral researchers, it is unsurprising that, without exception, all praised the role which technology played in their work. This was most evident in those engaged in computer programming. Christine praised the tools at her disposal and for the advantages they brought for researchers in general.

> *"I don't know many fields of study… where technology is not tremendously important. I'm a mixed methods researcher, so I use programs, you know, statistics programs all the time. I do a bit of programming in R. I've started to dip my toe into Python… I think that we are all immersed in technology these days and finding good and productive ways to work with technology that enable you to do what you want…and don't waste your time [is]…I think, a really important skill for modern researchers." (Christine, lines 93-98)*

Monica, whose work included extensive programming, was emphatic that technology not only enabled her to work with speed and efficiency, but also to do so from home with greater convenience. Christine and Monica's comments demonstrate how the benefits of technology are not limited to general tools such as word processing and spreadsheets but apply to specific advanced research tools, as well as communication tools which facilitate supervision.

> *"So, there are methods of doing stuff without technology, but it would be a lot harder and a lot slower. But in order to do the level of study that I'm at, I absolutely rely on the computer…I actually get a lot more done because I have the ability to completely work from home, because I have the computers and ability to meet with my advisors online." (Monica, lines, 41-42, 49-51)*

The substantial endorsement for technology aiding work was notable in those whose work involved statistical analysis. Alexandra, likewise, celebrated the time saved due to the tools she used.

> *"if I weren't, like, a very proficient programmer in R…it would have taken me, I don't know, maybe nine months or a year to do what I was able to do in like, a month and a half." (Alexandra, lines 343-344)*

She elaborated on this at some length:

> *"you know…I was taught how to hand calculate a regression, and I did it in my master's degree…you know… I could if I really needed to dig deep in my brain and… consult a reference to. Next of the exact formulas to calculate something… but like, why would I do that?" (Alexandra, lines 1352-1355)*

Positive aspects of technology for researchers went beyond the specific rigours of programming and statistical analysis. Sheila remarked how her life was made easier through possessing the technological means to record and gather data as well as create particular experimental designs.

> *"It makes, makes life easier because data collection is faster, and…it allows you to record data that they wouldn't be able to…or have experimental designs that they wouldn't be able to do without technology…it allows me to create different experimental designs." (Sheila, lines 857-859, 901-902)*

Whilst Sheila referred to being able to conduct novel kinds of work through technological innovation, Maya spoke enthusiastically about how ChatGPT could assist her as a non-native English speaker, although her specific use here, in winning an award, raises questions of the ownership of work.

> *"I'm not a native English speaker. So, I struggle a lot with the language. And sometimes the idea, but you don't know how to express it…So, I just explained it to ChatGPT. And then he would just tell me how… I use this for the three-minute thesis competition. And it's helped me so much in preparing my speech, which won the People's Choice Awards. So, I should really acknowledge ChatGPT." (Maya, lines 460-462, 468-469)*

Perhaps the clearest illustration of technological innovation aiding research occurred in the interview with Emir, whose example leads us directly into the next sub-theme, which concerns the potential environmental and ecological benefits respondents associated with technology use.

8.2.4 Ecological Benefits of Technology

Emir spoke at length about how his use of tools designed to simulate the physical environment, was not only explicitly orientated toward responding to climate change but key to facilitating the novel contribution to the field he was making:

> *"I'm using technology a lot in my PhD because I'm working on simulation software…I modelled a… high-rise building, and I'm evaluating its daylight and energy performance…So what's novel in my PhD is about climate, adaptive building facades… and when climate changes, my building's facade is responding towards the changing climate… and that's how it's saving energy…you change just one thing in the building and everything changes. For example…you just double the window size, and everything changes in the simulation model." (Emir, lines 18-30)*

On a different front, Christabel was one of many who spoke about the reduced need to travel, which technology afforded.

"I've moved home to Scotland to be with family and friends, which wouldn't be possible without the use of technology. I would still be in Belfast if I had to be. ...And then also, in terms of...the flexibility of... doing the interviews and stuff with people all over Northern Ireland. I didn't have to travel across the country." (Christabel, lines 443-447)

Of those cognisant of the reduced need to travel, which videoconferencing and other technology afforded, Alexandra was explicit in linking this to environmental costs and the university's sustainability policies:

"I prefer working remotely, and it's been a change for me, going from being completely remote at my job in America to having a job that wants me in the office three days a week…Um…I do think…working remotely is…consistent with the university's net zero and sustainability policies… do we all really need to come in all the time when we just sit in our offices by ourselves?" (Alexandra, lines 974-978)

The responses presented here bear witness, not only to possibilities inherent in online action, but also to the socio-technical and socio-cultural environments of research and how technology is now inscribed into research practice. As well as the benefits outlined above however, environmental costs of technology use were also raised– principally, though not exclusively, in relation to AI use. Accordingly, I now turn to the negative aspects of technology use as seen by respondents.

8.3 Negative Aspects of Technology Use

The interviews pointed to a diverse set of adverse experiences and concerns. These can be regarded as structural and technical issues which impacted well-being, and scholarly practice. As can be seen from the interview material reviewed below, below, the ways in which technology was thought to exert a negative impact markedly exceeded the perceived positive effects.

8.3.1 Environmental Costs

During her interview, Christine moved from discussing the benefits of videoconferencing, onto the environmental impact of travel, particularly in relation to attending academic conferences, and who bears the brunt of the impact.

"...I think that it's got a lot of potential in terms of equity, particularly to do with the Global South, and I think we should be…looking at how we can use it from that point of view, we should be looking at whether it's a good idea in terms of avoiding the environmental costs of taking flights to go to conferences." (Christine, lines 1061-1064)

She continued,

"I had a…thing in Germany a few weeks ago, and decided, because it was European Union, they gave you slightly better travel costs if you didn't fly… if we invested…took the subsidies

> *away from the airplane fuel and gave it to the trains, we could probably do quite a lot in terms of making trains cheaper…I fear that the people who end up paying for these problems…are going to be…in the poorest parts of the world…who have probably the least…power to actually affect change." (Christine, lines 1089-1090, 1106-1108, 1122-1124)*

This led her to reflect on the broader relationship between technology use and environmental cost. For her, the negative effects of technology extended well beyond any direct effects on her personally:

> *"And looking at it holistically…if we decide we're going to do it this way, then what will change? Because, if it just means that… nobody is buying a new computer, we're just using the technology. We have to do something that's a little bit extra, that's probably not terribly harmful, if the result of this would be suddenly a whole bunch of extra people are buying a whole bunch of extra technology…you need to look at…what's the environmental cost of that?" (Christine, lines 1139-1143)*

As stated, the environmental footprint of technology use was more likely to arise when contemplating the consequences of AI, although, as is evident below, this was but one of the large number of concerns which participants raised.

8.3.2 Problems with Artificial Intelligence

8.3.2.1 Environmental Cost

Two respondents, Alexandra, who we have seen connected remote working with sustainable working, and Samantha, both questioned the environmental load of artificial intelligence, with questions also raised about the ethics underlying the development of generative AI.

> *"I have concerns with…the training databases Open AI uses for their generative AI, and that, people did not consent for their intellectual property to be used in it, and also…the carbon footprint of generated by [the university], like search queries is astronomical." (Alexandra, lines, 51-58)*

> *"…And there are serious problems with the information you get by asking questions of generative AI… like the carbon impact, so… ask a program like Open AI or ChatGPT a question … the greenhouse gas emissions from that are like a year's worth of regular server information generation." (Alexandra, lines 433-435)*

> *"How are these websites still running, where servers have a cost? Even…assuming they have their own servers, which is very unlikely, the cost of electricity is still pretty expensive." (Samantha, lines 1290-1292)*

This was but one of a long list of potential problems which respondents, either foresaw or had directly experienced. These included provision of false or misleading information, risk of hindering creativity/plagiarism, and the violation of privacy/intellectual property rights. Illustrative comments from participants under each of these headings are presented below.

8.3.2.2 Misleading info/errors/false references/coding

The creation of misleading information and inaccurate referencing by ChatGPT was frequently invoked. These comments from Christine, Samantha, Nicola, Harold and Deirdre are typical of the problems encountered and which had led them to distrust the output they were receiving.

> *"…I had a bit of a look at ChatGPT 3 in relation to a course I was teaching, and found it …not just useless, but…misleading with the information it was giving. And…that was … incredibly useful, because it meant that I was able to feed that back to the students I was working with and let them know, do not trust this! ..what you're getting is not something that is produced with consideration of truth or falsity." (Christine, lines 41-44, 71-73)*

> *"It's not really the best idea to ask ChatGPT for guarantees, because it can make up…papers that do not really exist…I don't really believe too much what ChatGPT tells me." (Samantha, lines 453-455, 473)*

> *"I did run into some issues with ChatGPT. It happened once or twice…that ChatGPT invented references." (Nicola, lines 296-297)*

> *"I found the answers…ChatGPT gave me…were not like, very scientific or…I found… the references that ChatGPT, you said they were not like that good. So I stopped using it." (Harold, lines 245-247)*

> *"I do think we're in a transition time where we want ChatGPT to be a search engine, and it kind of is, but it kind of isn't…and I think…it's what your prompts are, what it gives you is only as good as your prompt. But it will never…just say, I know nothing. It will give you an answer …all the references it gave me were wrong and that made me nervous." (Deirdre, lines 867-874)*

8.3.2.3 Risks: Plagiarism/Lack of Creativity/Violation of Intellectual Property Rights

Sheila was the most vocal of the participants when it came to what she saw as the creative limitations of AI and with it the potential limitations for students who were seeking to do novel work.

> *"Artificial intelligence cannot…generate new knowledge, so artificial intelligence will replicate all the knowledge and arguments that are already existing… So, if you're doing something new and you're trying to, let's say, for example…that pitch iced tea is good for your eyesight, and there is no evidence around that it is. AI cannot write an essay about that because it's novel. It hasn't been done before…that actually this novel argument here belongs to the student, because AI cannot synthesise it, because it doesn't have this connection previously in the literature" (Sheila, lines 2473, 2480)*

In this she was supported by Nicola, who speculated on the motivation which she believed underpinned the sacrifice of one's own thinking in favour of machine generated output.

> *"I think that's definitely a risk that comes with generative AI and then obviously independent thinking, critical thinking, maybe sometimes it's easier to ask ChatGPT for ideas than trying to come up with your own...It's harder. Maybe they're not as good, they're not as creative. And so, I think… I could imagine that it reduces our patience a bit in the long run, and we're just after a quick response for something, so we fall back onto ChatGPT… rather than putting in our own cognitive efforts." (Nicola, lines 358-363)*

In moments of honest self-criticism, the issue was also broached by both Wei and Deirdre, who admitted their own culpability in relying on ChatGPT. In doing so there was a clear worry that they were being changed in a way they were not comfortable with.

> *"Sometimes I feel myself rely too much, rely on that software, like I cannot think by myself, or sometimes I need to… think by myself, because, you know, you have a tool, very efficient, and he can just pop up a question, they will give you an answer immediately, rather than think by yourself." (Wei, lines 347-350)*

> *"I'm still worried about using it as a shortcut for processes that actually are meant to be difficult…worried it will deskill me…I worry that it's changing the way I think." (Deirdre, lines 664-665, 704, 714)*

Deirdre ventured further and believed the issue of plagiarism surrounding ChatGPT use was causing students a good deal of trouble. She also worried she was being unwittingly changed in some way, and that there was a risk of losing something fundamentally human in the research endeavour.

> *"And…you know, it's causing lots of trouble for undergraduates, particular…it seems to be causing lots of trouble." (Deirdre, lines 2829-2830)*

> *"But AI, as sophisticated and wonderful as it is, isn't human thought. And the ability to think sideways without linear connections is…a uniquely human thing, and I don't ever want to lose that." (Deirdre, lines 767-768)*

The psychological importance of ensuring the presence of a human element even when working with ChatGPT also drew comment.

> *"I still think ChatGPT for now can only do some simple or baby step work, but for like reading articles, synthesise and summarise tons of references. It still needs human work to do." (Wei, lines 806-807)*

How participants understand this human element and how, in their view, it differs from machine generated output is a subject for further research. It is one which may evolve as the capabilities of AI systems grow.

8.3.2.4 Violation of Intellectual Property Rights

Alexandra, who previously voiced unease about the implications of generative AI for the climate, extended the reach of her ethical concerns to include potential violation of intellectual property rights. She spoke about this at some length, covering issues of consent, the untraceable nature of data sources AI relies upon (perhaps one reason for the unreliability of referencing), and the legality of how AI engines are trained.

> *"I have concerns with…the training databases that Open AI uses for their generative AI, and that, like people did not consent for their intellectual property to be used in it." (Alexandra, lines 51-52)*

> *"…the data that Open AI uses, you can't trace it back to its sources, and they're using the intellectual property of people like me…without our consent." (Alexandra, lines 463-464)*

> *"There are serious ethical concerns with…you're legally not entitled to just scrape anyone's information off the Internet and then use it for profit enterprises…there are copyright and intellectual property laws across the world…and the people in charge of Open AI have admitted…they're not able to verify all of the information used in their training databases, in their training sets, has been appropriately sourced." (Alexandra, lines 478-482)*

Her final reflections on this were based on the unsanctioned use of her own intellectual property, the only respondent to connect the potential violation of intellectual property rights to their own work.

> *"I have a website where I write about public health topics. Open AI can take that intellectual property that I created, is my ideas and my science and my learning and my words, and they can use that in their training database, and then use that to answer the questions or respond to… queries… that people are requesting. I have not consented to my data being used in that way, and that is fundamentally different than what happens when someone Googles something, and one of the results for that search is an article I published." (Alexandra, lines, 503-508)*

Some of Alexandra's unease was shared by Samantha, who referred to her understanding of the different rights existing in Europe and the United States with regard to training AI models.

> *"And, and this is more like, these are comment about Meta. Specifically. I remember when early June, they released that they were going to use whatever was published to train their own the Meta AI model. And, you know, in…the, you're in the Eurozone, it was possible to opt out, but in the US, it was not." (Samantha, lines 1306-1309)*

8.3.3 Over-Dependence on Technology

Besides the undoubted importance of technology use and the functional consequences of employing it, several respondents felt their own extensive use of it came at the cost of over-reliance. Samantha, for example, felt her life was to some extent dominated by it.

> *"I…think I spend way too much time using technology, but I also don't have an alternative…there is hardly any moment of my life that I'm not looking at screen." (Samantha, lines 1797-1798, 1805-1806)*

She went on to say

> *"I don't think that really, we could go without some sort of computing process, sorry, computing device." (Samantha, lines 2856-2857)*

What this entailed for her was a challenge, a need

> *"to understand how to live in a universe that…I'm already surrounded by all these pieces of technology." (Samantha, lines, 1673-1675)*

This reliance upon technology had precipitated a feeling in some that they could no longer imagine their life and study without it.

> *"Let me think, without technology, what would… we do, for example, if we didn't have any technology? (Emir, lines 57-58)*

A review of the historical literature in any discipline could provide answers to this, as would discussion with more senior colleagues, but the huge influence which it now exerts entailed for the participants a narrowing of the horizons within which the academic imagination worked. For some this opened the door to serious problems with time management and potential addiction.

8.3.4 Addiction / Time Management

Many interviewees spoke of the difficulties managing their time with technology. Their accounts suggest an institutionalised culture of technologically produced addiction, detailing excessive amounts of time spent in front of a screen as well as the often, habitual nature of computer use.

> *"Computers, I sometimes spend, like, a lot of time, because I have to when I am writing, for instance, I can be easily…12 hours in front of a screen. Or as part of the PhD, I need to do some teaching and marking. And when I am marking, I do it…with a computer, of course. And… I can be like, 10 hours in front of the computer." (Harold, lines 1043-1046)*

For Harold, the same issues extended to smartphone use.

> *"I think that we all use the phone like, a lot, like even when we are walking down the street, we are checking things…like, social, media and everything." (Harold, lines 1052-1060)*

Samantha, meanwhile, had a predilection for gameplaying, the duration of which, like Emir's periods of computer use, could be extremely long.

> *"There are times where I can play it for weeks on end, and other times that I can, that I have more free time on my hands, so I can…more consistently play maybe every night before going to sleep, you know, like after work." (Samantha, lines 2636-2638)*

This was associated with an intrinsic feeling of reward, which she likened to taking a "hit".

> *"Yeah…it's like, for me, it's…*
>
> *a sort of entertainment. So, I definitely do get the dopamine hit when…you know, I accomplished something that is, that is great, like defeating a boss, perhaps, or something like that. But at the same time, I find it like an engaged version of a TV show." (Samantha, 2658-2662)*

As the following extracts indicate, she was mindful of struggling to manage her time in relation to work - a battle between her judgement as to what was best for her work and a pull to continue game playing.

> *"I still realise that even when I'm playing a video game or something like that, and it's giving me some dopamine, or…a sense of accomplishment, I still understand that this has nothing to do with what I want to do. I'm very motivated to become a good engineer, or to progress in my study, to learn more things." (Samantha, lines 2716-2719)*

> *"At some point you realise, you know, if I could also play the whole night, but then I realised that at 4am I'd have, sorry…let's say, 5am I'd have only three hours of sleep before I have to get up and go. So, you know…is it worth playing four more hours for an entirely miserable day instead? Isn't it better if I can keep a tight schedule and tomorrow, I can play more?" (Samantha, lines 2743-2747)*

Despite remarking that game playing had "nothing to do with what I want to do," *s*he insisted this was not yet a problem.

> *"So far, it's not been a problem for me that I've overplayed, or what I felt like I was behind because I gave too much time to video games." (Samantha, lines 2722-2724)*

The habitual nature of computer and smartphone use was referenced by several participants. Natasha, for example, spoke of the "the urge to check the chat to see what's going on." *(Natasha, line 219)* while Slaveia referenced the apparent ease with which computer use could take precedence over social interaction.

> *"…sometimes I use a computer too much, more than I would like to have. Sometimes, in the evening I would be too lazy to go out, and I would just use my computer…It's just using the computer is easier than going out… I guess sometimes you can get a bit too focused on technology and maybe forget a little bit about other things and taking care of yourself." (Slaveia, 1272-1273, 1281, 1323-1324)*

There were other ways in which participants discussed the problems of managing time on computing devices. Deirdre mentioned difficulties managing her interactions on different platforms as well as the latent demands of mobile phone use.

> *"I think that there is a real danger…your phone being on 24/7 and Tik Tok. I'm very allergic to, you fall into a Tik Tok call, and you never come up for hours." (Deirde, lines 1243-1248)*

She experienced this as something she had difficulty controlling.

> *"I feel it's not benign. It's not just entertainment…that it's addictive." (Deirdre, lines 1271-1275)*

> *"So, I've tried to control it, because otherwise it… just takes over." (Deirdre, lines 1399-1389)*

Sheila, too, raised the prospect of addiction in contemplating engagement with social media.

> *"However, if you are addicted to social media, so you're all the time…talking on Instagram, posting photos on Facebook and stuff like that. I think it can hold you back from your studies…I think actual communication or a phone call with them is probably better than hours on social media and not actually interacting, because it can be very addictive." (Sheila, 915-916, 1629-1631)*

Resonating with the survey data, this negatively charged relationship between technology use and time management, was also associated with the sense that this was adversely affecting work.

8.3.5 Hinders Work

While diligent in establishing a routine of coming into the office “four out of five days,” Nicola was mindful of an ever-present threat of distraction.

> *“That helps me to not get so distracted.” (Nicola, lines 823-824)*

The source of her distraction, she acknowledged, was excessive smart phone use.

> *“I spend too much time on my phone. My screen time is…really high… I think four and a half hours a day.” (Nicola, lines 858-859, 864)*

There was also “procrastination” engendered by “social media.”

> *“I think I could probably get more done at work if I wasn't on social media that much.” (Nicola, lines 815-816, 883-884)*

She summarised the overall effect of this on her work:

> *“…in terms of hindering my progress again, my phone.” (Nicola, lines 965-966)*

Natasha discussed the ease by which she could be distracted by being able to chat with others on her phone.

> *“I just have a lot of people that I'm quite close to on there… so…when I want to talk to them, it can be quite distracting… I can still do my PhD work, but it would be at a slower pace than if I didn't have those distractions.” (Natasha, lines, 190, 196, 293-294)*

This propensity for distraction was, to a degree, a function of how she was managing her work.

> *“I tend to ... distracted more easily if, maybe I'm stuck on something in my PhD.” (Natasha, lines 234-235)*

Nicola’s and Natasha’s views on being distracted from work were echoed by Harold,

> *“Social media takes… a lot of time from you as well…although I don't have Instagram or Tik Tok…because I prefer not to have it and get distracted. It's true that… social media can…hinder ...your work productivity…Absolutely.” (Harold, lines 1236-1238)*

Harold, aware of the potential distraction from Instagram and Tik Tok, nevertheless lamented how his use of other platforms, such as WhatsApp and Facebook, could be a drain and committed himself to limiting their use.

> *“There are like…13 times, where I am, like, really, truly busy that I stopped ...and I stopped looking to this, to this media, except for like, one or two contacts that maybe are important… I need to focus on myself or on other work.” (Harold, lines 1283-1286, 1291-1292)*

Sheila, too, reported how work was adversely affected by technology. For her, this could be a consequence of the draining effect of exposure to bad news.

> *“You know, if you see all this information… even if it's news, it gives you headache… And if it's bad news, it also ruins your mood. And then you might not have energy or might not be in the mood to study anymore.” (Sheila, lines, 2261, 2267, 2290-2291)*

But it was also seen as contingent upon the unceasing demands of being reachable 24/7 through notifications from social media groups.

> *"I remember when I was part of a big group of PhD students that it was kind of annoying, and it reduced my productivity, because everyone kept posting there…all the time, and it kind of upsetted me because I kept receiving notifications." (Sheila, lines 987-990)*

The seemingly inescapable reach of technology was one of the reasons participants spoke of feeling overwhelmed.

8.3.6 Information Overload

Another common problem, voiced by many, was that the ease of access to enormous quantities of information, combined with being in the constant reach of other people, could at times feel overwhelming. Sheila described it in terms of there being

> *"too much information that is not useful, and you don't really need it." (Sheila, lines 2273)*

Harold and Slaveia added to the chorus, wary of the incessant communication.

> *"…been kind of burnt out with all the things, because when you have, like, a lot of things already, and then you have emails coming all the time, and they can reach you on your phone and easily." (Harold, 1204-1206)*

> *"I was over, uh, saturated with notifications and friends messaging me." (Slaveia, 1246-1247)*

For Slaveia, this amounted to

> *"a lot of distraction. It takes a lot of time." (Slaveia, line 1255)*

It took a lot of time before she realised there was no need to immediately respond to the messages. Eventually it

> *"became kind of like the norm that you don't have to respond right away." (Slaveia, line 1255-1256)*

As can be surmised from these comments, there is considerable overlap between the habitual use of technology use, its proclivity for distraction and interference with work and the sensation of being overloaded with a constant stream of information. But there was a further distinct aspect of this, the consequential toll on health and well-being.

8.3.7 Health and Well-Being

In line with the survey findings, several participants spoke of their health being affected by technology use. This encompassed problems with eyesight, posture, sleep, energy, and mental health. For Maya, Samantha and Wei, the primary issues were with their eyesight.

> *"I think it's not very good for both the brain and also for the eyes. Yes. I think it gets worse when I started my PhD. Okay, always in front of the laptop, all my work is in the laptop… As I said, just my eyesight." (Maya, lines 1806-1807, 1880)*

In Samantha's case she thought the problems were exacerbated by the pandemic and attributed this to the increased reliance on videoconferencing that came with it.

> *"But my problem was that I think that's where my eyesight also started to get poorer. Because while at the beginning I was just looking at a screen when I was at home, then it became I was home the whole time, and all my lectures were done through that. So, I started looking at a screen for the better part of a day…I guess this… definitely catalysed the process." (Samantha, lines 1138-1143)*

Samantha spoke further about the insufficiency of workplace guidelines on limiting screen time to fully address the problem. She explained how the guidelines take no account of the fact that technology use can be habitual.

> *"So, I to be fair, reading the guidelines of…what is it called, the safety in the workplace, we're supposed to take a break every… two hours, in which for 15 minutes you're not supposed to use your eyes. But with not using your eyes for work, doesn't mean you can then stop looking at the monitor screen, then you start looking at your phone or for what it matters, even reading, because that still puts a strain on the eye, so …What should I do?" (Samantha, lines 1159-1164)*

Wei spoke of spending a lot of time on "ChatGPT, Google Scholar, this kind of stuff" with the result that,

> *"My eyesight gets worse and worse…I think is really not healthy." (Wei, lines 2453, 2460, 2463)*

Samantha also referred to the consequences of prolonged engagement with technology on her physical posture.

> *"Physical well-being also definitely. Working with a laptop mostly means that we are going to be sitting on a chair… and that's not…great for our backs…I try to adjust my posture as much as I can. I am very conscious about it. So, at times I will remember, I'm leaning too much into …the screen. I just straighten it up. So, I do… some stretching on my neck. (Samantha, lines 1940-1941, 1947, 1636-1638)*

Sleep was a further health issue, which several reported was affected by lengthy technology use.

> *"It will affect my sleep negatively, because, you know, like, if you're on your phone for too long, it's harder to fall asleep." (Natasha, lines 1338-1339)*

> *"I use my phone quite a lot lately. And it's true that it reduces…sometimes…my sleep time." (Harold, lines 944-945)*

> *"So technology…I think it sometimes affects my sleep, because when I just close the…laptop. I just go to bed to sleep, but it's not possible sometimes." (Emir, lines 1392-1394),*

Several respondents mentioned potential negative effects of screen time on well-being. For Samantha and Nicola this was a consequence of sheer exposure time.

> *"…in terms of problems, I think there is definitely over exposure to technology, especially screens. I would say, I don't I always try not to use EF plugs or things with too much high*

volume so that I'm not… deafening myself. But screen overexposure is…the biggest problem for me." (Samantha, lines 1832-1834)

"I spend too much time on my phone. My screen time is really high...I think four and a half hours a day." (Nicola, lines 859, 864)

Like Nicola, Sheila was critical of the debilitating effect of excessive screen time, lamenting the draining effect on one's vitality.

"Sometimes I might feel tired after exposure to technology for so long. You know, screen time is sometimes too long." (Sheila, lines 398-399)

She also commented on how the nature of social media, in inviting constant social comparison, posed a further threat to mental well-being.

"it's not good for the mentality, because it makes you compare yourself with other people." (Sheila, line 1637)

Monica also believed social media had a negative effect on her mental health.

"My mental health just continues to decline when I use social media, so it's just not worth it." (Monica, lines 2202-2203)

In her case, however, this was a result of exposure to a torrent of misinformation and being disturbed by how easily people could be taken in by it.

"It's just, it's also extremely sad to watch people that you care about fall for a bunch of lies and misinformation." (Monica, lines 2193-2194)

Wei was also critical. Mindful of the competitive spirit that can be encouraged through social media, and in the context of the demands of academic life, he felt this had a damaging effect on mental health.

"People tend to share the positive side of their life and academic achievements. So…if you click one post, it will continue to send you similar posts, and you receive lots…of information similar to the post you read… it makes me draw into a very competitive mode that I think I need to keep learning, keep thinking…because I'm less competitive in the job market…But those people … they have like, three or four publications during their PhD.…So, it makes me feel very anxious, depressed, and … not helpful for my mental health." (Wei, lines 386-407)

Finally, in a somewhat different example, Deirdre was concerned about the effects set in motion by the computer algorithms which shape much of modern life.

"The algorithms on Spotify, you know…Spotify will learn what you like and then throw you a new piece that they think you might like, and then if you skip it, they know you don't like it. You know, the algorithms behind these things are very clever. So…algorithms for advertising can do us harm (Deirdre, lines 2695-2699).

These comments illustrate the multifaceted nature of the relationship between technology use and well-being, with implications for the exercise of both personal and institutional responsibility.

8.3.8 Technical Issues

Many of those interviewed talked about the technical problems they encountered. These covered a wide range, which can be broadly grouped into hardware failures (data loss through outages and insufficient storage; connection problems), or problems with software (transcription errors; problems with bibliographic software; unstable software, or software which was poorly designed or complicated to learn). Examples of each of these are provided below.

8.3.8.1 Problems with Hardware

Harold provided several examples of hardware failures he had encountered.

> *"But also, it has this downside that if there is a minimum fail… like everything goes wrong. So yes, I have lost, like a lot of data, for instance, because of some…misconnection with a high external hard drive or something." (Harold, lines 120-124)*
>
> *"like technology, there are a lot of things that could go wrong…you can lose your internet connection, your laptop can die, and that could be a problem." (Harold, lines 688-689)*

Sheila briefly referred to her laptop breaking down, though she was fortunate in having backed up the data on a USB drive prior to the hardware failure.

> *"What happened on my first year on my PhD? It was my laptop burned because I was using it and it was like an old laptop, and I was using it with some new eye tracking machine…But it was… very demanding. So, my laptop broke, and all the files I had there…disappear. Basically, I've lost all the files that I had on my laptop." (Sheila, line 264-267)*

Nicola encountered issues with storage capacity.

> *"I had massive issues with technology for the longest time during my PhD, I used my private laptop, which is not the newest model, and I ran into storage issues at some point." (Nicola, lines 151-152)*

8.3.8.2 Problems with Software

Respondents drew attention to technical problems with a wide range of software. These highlighted functional limitations and software instability, inadequate training models underlying it or else technical difficulty in using it. Several experienced serious problems with transcription software or remarked on its current limitations, which stemmed from inadequate training for voice recognition. These led to social biases (by region, accent and class) in transcription or omitted important paralinguistic aspects of human conversation.

> *"{I} used Otter AI initially, and that ended up… being more work because the accent in the North of Ireland, it's just… not comprehensible to Otter AI, and so I was having to correct every single sentence and it was just easier…to do it myself… if I were studying in the States… or…the South of England, and my study participants were posh…perhaps it would have*

> *worked better, because the algorithms are made to ...accommodate those accents." (Alexandra, lines 59-61, 71-74)*

> *"I record the interviews, and then I've been uploading that to do the initial transcription, because it takes so long to type and transcribe… I would listen to the recording many times and make sure it's all correct, and ..also add in the thing that technology doesn't do…all those little human bits into the transcription. And for me, they're really important…AI generated, loads of mistakes." (Deirdre, lines 521-529, 1531-1533)*

A further issue raised related to bibliographic software. Deirdre was particularly animated about the problems she'd experienced.

> *"I don't use bibliographic software because rubbish in is rubbish out. When I find a paper, I actually keep a long running list of completely accurate references, because I've learned the long and hard way…you can end up spending hours correcting." (Deirdre, lines 539, 545-546, 553)*

Wei, although finding the bibliographic software he was using "quite easy," also found it was necessary to intervene manually to correct the output.

> *"I think [it] is quite easy…some references I download still have problem…I download the citation ...and they write their topic in all capital letters…I need to change it." (Wei, lines 1405-1406, 1420)*

Several issues raised concerned shortcomings of videoconferencing software. Wei, for example, referred to its lack of stability.

> *"[it]...is also not stable ...not just voice qualities. A first, it asks you lots of time to send them the code from the authentic, authenticators…So it asks your login credentials, multiple times, which is quite annoying," (Wei, lines 1647-1660)*

Several also spoke in less than flattering terms about both Teams,

> *"I think that Teams has a better interface, although the program itself, I found it a bit buggier, in general, with non-mobile devices." (Samantha, lines 669-671)*

> *"Teams sometimes can be a little bit problematic in terms of connection or just getting the program started." (Nicola, lines 674-675).*

And Zoom:

> *"I felt, I feel that when, when the meetings become bigger…Zoom is not really efficient at keeping… up with multiple speakers. I think if it's a lot of one-way interaction, then it's good." (Wei, lines 666-668)*

In addition to programs being unstable or poorly designed, students occasionally referred to the technical difficulty or complexity involved in engaging with specific technology. As the extracts below indicate there could also be an emotional cost, whether grief, frustration or panic. Emir's work for example required use of simulation software (*Rhinoceros Growth*) to evaluate the energy performance of a designed building. For him, the difficulty of the software was compounded by the circumstances of the pandemic.

> *"I was a bit frustrated to use this software because it's very complicated. And as I said, I had to learn it alone during…lockdown time, sometimes I was crying. It was not easy, I think…it was very tough time, COVID time and alone learning the software…It was so frustrated." (Emir, lines 633-638)*

Slaveia made similar comments regarding her experience with *PsychoPy*, an open-source program for running experiments in psychology and neuroscience.

> *"It does have a lot of issues and is being updated all the time. It is open source, so it's maintained by people of goodwill, and there are issues there. Of course, it is not really straightforward to understand in the beginning, so I did have a lot of frustration with it…hence, it was not helpful." (Slaveia, lines 393-395)*

As did Nicola when it came to the programming language 'R'.

> *"I used R during my master's degree…Yes, back then, I found it very difficult." (Nicola, lines, 491, 494)*

Finally, Samantha detailed her difficulty in using Project aggregators (a tool/platform for collecting and organising information from multiple projects).

> *"I had never used this kind of...project aggregators…my first reaction would be bit of shock, because…I wouldn't know how to even navigate…the user interface. I would just see a bunch of packages, files and folders, and if I have to do anything besides unzipping it, I would be kind of panicking. So…I think, and I wish…there were more gradual trainings about how to use these softwares." (Samantha, lines 597-603)*

It is evident from the above that the widespread presence of technology, despite its function to automate and improve tasks brings with it a propensity for new difficulties and forms of error which require a human presence and outside intervention to deal with them effectively.

8.3.9 Importance of the Human Element in Interactions with Technology

One of the most frequently raised issues, and one which dovetailed with the survey findings concerned the effects of technology use on social interaction, and the importance of the human element in technologically situated work. These concerns could be found in several specific sub-themes, which are presented below.

8.3.9.1 Lack of Social Interaction and Social Isolation

The loneliness of scholarly endeavour came up in several interviews and is undoubtedly a contributor to students' mental health. This feeling was associated with the individual and specialist nature of doctoral research, as in the following examples.

> *"The most important thing is most PGR students feel lonely because you're working on your own." (Wei, lines 1762-63)*

> *"You know, PhDs are lonely…I don't talk with, I'll message a couple of the other students, but …the type of work that I'm doing isn't similar to anybody else's." (Monica, line 891, 1012-1013)*

Loneliness in the course of study was also framed as a consequence of the pandemic. For this, technology offered something of a respite.

> *"I've been very grateful I had an opportunity to keep in touch with [friends] during COVID, so I was kind of happy… to see another face through a video call and talk with someone while being isolated, rather than not having it at all….It wasn't perfect…it's not the same as… face-to-face, but it's still better than having nothing." (Sheila, lines -656-659)*

But while technology offered some social benefits during the pandemic, others felt that in different contexts it could engender the opposite effect, eating into one's social time.

> *"If I don't have my computer around, I would socialise more, and I would…just go out a lot more. For example, here in Bulgaria, if I go to the countryside, if I have my computer, I would use it a bit more. If I don't have it, I would find other things. So, yeah…It does affect social life." (Slaveia, lines 1231-1233)*

Slaveia appeared to be suggesting that computer use risked becoming habitual and that without due effort, could take precedence over social interaction in the real world. Others also thought that technology exerted a huge effect on their sociality. For Maya, this awareness came in the aftermath of pandemic-imposed isolation.

> *"My first…six months were completely online. I only came to Manchester after six months… I was still having meetings online…maybe six more months…In that time, I had to go to the office… It wasn't like a restriction, but it was recommended to only go for two days. So, I couldn't meet other students. And it affected me in many ways. So, when I came to Manchester, I started to see other students, talking to them. It helped me understand what a PhD is trying to do and what everyone's doing, and…meeting people in person…made a huge difference to me." (Maya, 1488-1494)*

On reflection, Monica felt her computer use was having a negative effect on her relationship with her husband.

> *"Well, when my usage goes up, sometimes it's harder to connect with my husband." (Monica, line 1466)*

All these expressed feelings were premised on an intrinsic valuing of human contact and interaction, that could not be entirely realised or replicated virtually. But they also highlight once again the conflicting possibilities, for good or ill that technology opens up.

8.3.9.2 Intrinsic Value of Human Interaction

For Harold, the importance attached to face-to-face interaction shaped his attitude to online education, in a way that was quite different to his friends.

> "*I have never done any online studying… full online thing. but I don't think it's something for me. I really like interaction, face-to-face with lecturers, other students and everything. So, I know that is, like, really important. And I have…a lot of mates that are doing online degrees…and that is really helpful for them in terms of their flexibility, they can work at the*

same time than the study… and it's in an easier way. But for me, it's not something." (Harold, lines 702, 708-712)

In expressing her view of the importance of direct human interaction, Nicola stated how she felt remote working adversely affected the sense of community in academic life, with people "hiding behind technology," even as she acknowledged its utility during the pandemic.

> *"I think it's an issue for the research community… the…sense of belongingness definitely suffers when you are only working remote. I think it's an ongoing issue here as well. But obviously technology was very helpful in the beginning, but now… because we got so used to it, people don't make the effort anymore to come into the office and meet with others, because it's very convenient to work from home. You don't have to commute. So, people hide a bit behind technology, because…even though you're not present…people can still reach you through technology." (Nicola, lines 768-774)*

She summed up her view by emphasising the emotional primacy of face-to-face contact.

> *"Generally, I would prefer face-to-face, just for yeah, just for the feeling. I mean…it's nice to have, like personal contact." (Nicola, lines 752, 758)*

These sentiments were to a degree echoed by Samantha.

> *"I know it definitely does add flexibility for people…studying part time, or…I don't know they are fathers and mothers of family, and so they have to take care of a lot of things while also studying...But…personally, I don't think I would be able to take it right now, because I know that my attention…would definitely not be the same in person verses remote. And…when COVID forced me to go through this…I was definitely not as attentive…through remote study." (Samantha, lines 1062-1069)*

As well as the attendant loss of attention which virtual communication entailed, Samantha went on to describe how videoconferencing came with a fundamental loss of vital non-verbal information, which affected how she processed the emotions of other people in a situation.

> *"Of course, this a personal usage of technology. I'm very happy that I can instantly talk to my parents, even if they are several time zones away…at the same time, I am also not a person that really likes texts in general, even video calls, in the long run… phone calls and video calls, they… can't really…completely replace human interaction. For me, I am more used to pay attention to all the inputs I'm receiving. So, body posture, no gestures, faces and each…individual level of technology, you know, from video call, phone call and text, each one is usually removing…information…So, it becomes harder for me to judge the emotions of the other person." (Samantha, lines 1923-1930)*

Beyond the issue of whether students' interactions with staff and colleagues were technologically mediated or not, several stressed how important and fundamental this contact was.

> *"Keeping in contact with colleagues or other PhD students that…are not at my university, so I can't meet face-to-face, technology has been really helpful to stay connected, And I would say it's part of the learning experience to have regular exchange with other PhD students, to just learn how they approach their PhD… to learn about their research…how they deal with problems." (Nicola, lines 112-116)*

> *"The university experience is definitely not taken advantage of if you're not interacting with other peers." (Samantha, lines, 1540-1541)*

Samantha was keen to stress how different the contact with friends and family was from the kind propagated through social media. In her mind, the latter offered only an illusory form of acquaintance.

> *"I don't think you're actually befriending someone that is, you know, followed by a million people." (Samantha, 3022-3023)*

> *"I think also with relationships… is just understanding who really matters and like what matters and what doesn't matter. So, say, one day you are in need…Are you going to call the person that you were following, or are you going to call your parents and physical friends that you have?" (Samantha, lines 3055-3057, 3063-3064)*

These remarks signal several distinct points about the value of technology mediated social interaction. They address the importance of social exchange with other PhD students, the distinction between genuine friends and people encountered on social media, and finally, the value of one's friends and family for social support.

8.3.9.3 Need for Boundaries Between Personal and Work Time

Several respondents mentioned the need to maintain a clear demarcation between home life and academic work. As Samantha argued, the nature of contemporary technology and our relationship with it had eroded this, making it increasingly difficult to draw a line between the two.

> *"There are two ways that I use technology. One is as a researcher, and…as a student. And to be fair, it's not like it's very easy to draw a line nowadays…with these two fields and personal life… …and all of a sudden, post-pandemic, everybody had to start using these devices. So, the work culture is…to have a part of the work always on your on your personal device as well." (Samantha, lines 34-39)*

Both Monica and Samantha stressed the importance of keeping these domains separate. Monica spoke of her strict enforcement, while Samantha worried about the invasive nature of technology encroaching on personal time.

> *"I'm fairly strict about trying to make sure that work stays at work and family stays at home." (Monica, line 1466)*

> *"Just because I have my iPad…and my phone with me at all times, it doesn't mean that after business hours, I'm supposed to read more emails or do more work…But I think that while it's definitely good that I don't necessarily have to step out of my house to work…there should still be a boundary between what is my personal life and what is my work time."(Samantha, lines 798-803)*

8.3.9.4 Training

Given the differing concerns students expressed regarding their experiences with technology, the potential problems which could arise, and the value and significance of human interaction, it is not surprising that several interviewees raised the issue of training around technology use. This was conveyed on several fronts; by reference to the need for more training, given how little they had officially received, the necessity of acquiring knowledge through their own efforts, and an acknowledgement of, and a preference for, training to be delivered by others.

Need for Training

Many spoke of having received no or very limited training in several areas of interest and expressed a clear wish that they had received more. For some, the demand for training was of a more generic nature – while others had interests in mastering specific tools.

> *"I think technology is a really important thing, and we didn't receive any training at all." (Deirdre, line 1820)*

> *"I think, and I wish there were gradual, maybe there are…but definitely, I wish that there were more gradual trainings about how to use…these softwares." (Samantha, lines, 602-603)*

> *"I would have loved to have more training about…imaging and video editing." (Harold, lines 448-449)*

> *"It would have been nice to receive more advanced training…how to create experiments specifically for psychology, because everyone is doing it, and we never had a good course on how to create experiments in Psychopy or…other software." (Slaveia, lines 462-464)*

Very significant outcomes were tied to the dearth of formal training. As Deirdre pointed out, this was particularly so when it came to ChatGPT, with ensuing anxiety for students.

> *"I think we could do with some training on how to use ChatGPT…I think…we all need some help understanding what ChatGPT is, what it can and what it can't do, and…where the positive aspects overlap with the negative…Quite frankly, whether we get into trouble for using it, I don't have any clarity…I hear…about people being taken to disciplinary panels because they've used ChatGPT and yet, surely it must be a tool for good as well. I personally would love…some training…that would have to be regularly updated, of course." (Deirdre, line 806, 2733-2737)*

Her recognition of the importance of such training stemmed from her own difficulties with the tool. Below she discusses how she could feel overwhelmed by the output generated, and how this related to a need for training.

> *"I can get overwhelmed with the amount of information that you've got access to…and I think that specifically, ChatGPT can be very overwhelming if you ask it to write something for you, and then it hasn't quite got it right. And then you try and get your prompt… I think, is really important, and if we're going to use it, I think we need some help learning what are good*

> *prompts, what information can you trust?...I think we need that quite regularly, because it probably changes quite fast." (Deirdre, lines 2489-2494)*

Slaveia went on to say how this training would have been useful from the outset.

> *"A course or two in the beginning of the PhD actually would be good." (Slaveia, line 1346)*

Training was also seen as being about more than just familiarity and technical proficiency with a tool. In Nicola's view training was important for its potential psychological benefits.

> *"…very useful just to develop my skills and my confidence as well." (Nicola, line 55)*

She described how at the beginning of her study she had undertaken training in a specific form of statistical analysis and how this had produced a very positive effect on her confidence.

> *"When I started the PhD, before I did anything else, I did a workshop, a training course for structural equation modelling …I think it was very important for me to do this…because I felt quite insecure in terms of data analysis and statistics. So, it was really helpful to build my confidence." (Nicola, lines 99-102)*

Finally, in reviewing respondents' views on the need for training, it must be noted that one person - Sheila – mentioned that she had personally known students who were too proud to ask for help with technology, even though they might need it:

> *"Because I've known students from my university, some of my friends, they didn't want, they had to use specific software for analysis of their data, and they didn't know how to use it, and they didn't ask their supervisors, because they were too proud to ask for help." (Sheila, 2580-2582)*

Self-training

A lack of formal training meant that most of those interviewed had acquired their technological knowledge largely through their own efforts, which, as is made clear below, could involve considerable commitment.

> *"Training. I don't think…I was ever trained into using something specifically." (Samantha, line 582)*

> *"I had to change whole methodology of the PhD, and I learned the simulation software during lockdown time. And it was so tough, nobody helped me… I had to learn the software on my own." (Emir, lines 341-342, 345-346)*

After training herself, Sheila subsequently found herself in the position of delivering training to other PhD students.

> *"…the amount of statistics that we were learning, so we didn't learn, in full extent, all the stuff that I've been currently doing...I had to train myself, and then I was the one who was providing training to others…after I learned it myself. I started…to help other PhD students in my department to learn it faster and easier. So, I created…a series of workshops, but we did that, I was teaching them…how they could do different things." (Sheila, lines, 483, 490, 497-499)*

8.3.9.5 Preference for Training by Others

Although Sheila had received online training on videoconferencing from her university, in her view, this was less than optimal and would have been better delivered in person.

> *"The university…uploaded a video to train us online. So, it was…a workshop, but it was training through a video, basically on how to use Microsoft Teams and how to use different functions… so, yeah, it was kind of training. It was helpful. I think it would be more helpful if it was face-to-face, if it was in person, but because…we had the COVID, it was very difficult for it to happen face-to-face." (Sheila 581—583, 596-597)*

Whatever the merits of online training, learning with other people was invariably seen as preferable and "good practice."

> *"I think it's nice to learn with others, especially a program like, M Plus, if you're not used to syntax-based programs, it's nice to suffer like together than alone." (Nicola, lines 527-528)*

> *"I have never done any online studying, like proper courses, full online thing. I don't think it's something for me. I really like interaction, face-to-face with lecturers, other students and everything. So, I know that is, like, really important." (Harold, lines 708-709)*

> *"I think that there are things like GitHub, GitLab,* they can be overwhelming, especially at the beginning. My professor is following me, teaching me because it's also good practice." (Samantha, lines 595-596)*

* A software development program.

Sheila raised the question of where responsibility lay for organising and delivering training to PhD students. She felt that this fell squarely upon universities and included not just the provision of training but the provision of information regarding what tools were available.

> *"Universities should be able to provide more training on technology within departments and within different expertises…What I would like to happen…is have more training for students, and when we are on the Welcome Week, it would be nice if people were telling us we have all this software available…give us an introduction…about what is available and how we can use it, and tell us there is the opportunity for training if needed." (Sheila, 1105-1106, 1235-1238)*

8.4 Limiting Technology Use to Aid Well-Being

This final subsection deals with one specific means by which students sought to cope with the digital intensity of their lives. As documented above, in addressing negative aspects of technology use, doctoral students complained of how technology use compromised their well-being. Unsurprisingly, they had developed several self-regulation strategies to combat these adverse effects. Each of these is considered as a specific sub-theme and discussed below. The first comprised the direct intention to limit technology use.

8.4.1 Limiting Technology Use

Finding his time was being wasted by excessive technology use, Emir opted to set limits on smartphone use when accessing social media.

> *"Smartphone, I'm trying to manage myself by setting 15 minutes limit per day." (Emir, line 1429)*

This strategy was reduced in its potential effectiveness in not being applied to all of the social media platforms he accessed. For example, he admitted to running You Tube for "maybe five hours" (line 1492) on average each day. The function of this strategy for him, therefore, was somewhat ambiguous.

> "*Sometimes it encourages me. Sometimes is distraction." (Emir, line 1521)*

Samantha, whose game playing was earlier framed as potential addiction, also sought to reign in her engagement with it.

> *"Sometimes I'm conscious of the fact that I don't know…for how long I can play a game…but…I'm also very mindful of the fact that I have other duties to do. So, I can't really…" (Samantha, lines 2888-2690, 2743-2747)*

It was, for her, a question of

> *"…I would say it's easier to keep the discipline. If there is nothing that can tempt you into mixing the two things. For me, it's about compartmentalising things to the timing, location and tool…separating job life and personal life in a physical manner." (Samantha, lines 1725-1727, 2044)*

For Slaveia, putting her phone aside was construed as a necessary part of "taking care of yourself."

> *"I guess sometimes you can get a bit too focused on technology and maybe forget a bit about other things and taking care of yourself. I would say I'm okay right now. I try to put my phone aside and do other things as well and socialise and talk to friends." (Slaveia, lines 1323-1325)*

8.4.2 Belief in Self-Reliance/Planning

With awareness of competing demands from technology use and work, a common response was to accept personal responsibility for the outcome, whatever this was. For Emir, this might mean prioritising giving support to friends over doing PhD work - which he attributed to "external necessities." He contrasted that with events which were his responsibility. For such external necessities, he remarked,

> *"I don't feel guilty or anything. But if it's my fault, then I try to learn from my mistakes." (Emir, lines 1244-1245)*

Samantha, too, subscribed to this philosophy of self-reliance. Regarding general technology use, she remarked at length on the necessity for personal accountability in how one divided one's time and then made use of it.

> *"The thing is…with every tool…it's up to us, the user, to figure out how to not get distracted, or how to use it efficiently… The only problem with that is…I think that separating the devices for personal use and for work use…it's pretty paramount, because this way, you can avoid being distracted…and waste time with things that are not necessarily related to work." (Samantha, lines 2354-2364)*

Samantha's wish to draw a line between technology use for personal reasons and for work did not address the fact that the devices used in each of these contexts are often the same. Her view is one which not only permits institutions to abrogate responsibility for raising awareness or providing training to minimise potential harms but similarly absolves software companies from their responsibility for design features in their products that render it conducive to reinforcing repetitive, harmful behaviour in users.. A comment from Slaveia, when asked whether she had received any help or advice from the institution, perhaps goes some way to explain why a philosophy of self-reliance had taken root in doctoral life:

> *"Um…I would say I've contacted it couple times to sort things with my computer, and they've done pretty well, nothing." (Slaveia, lines 1333-1334)*

Exercise of this personal responsibility by respondents could take various forms. It might entail planning specific activities for self-reward, or use of an electronic diary to assist in apportioning time – both linked to achieving concrete goals.

> *"We always had [a] reward after meeting… I think the reward would be either getting some nice takeaway… having some food all together and watching a movie or going to the cinema, we would organise, always something good after hard study." (Sheila, lines, 1836, 1842, 1848-1849)*

> *"I've made myself a little sort of routine, which is, you know…going to bed…at 10 at the latest, and getting up,…half seven, eight, which is a really good night's sleep… just getting into a really good rhythm… and…I have a diary…each week…I write out into a block chart what I've got to do and when I'm going to do it."(Deirdre, lines, 1686-1690, 1696-1697)*

Slaveia exemplified how personal organisation and planning were intrinsic to this perspective and went hand in hand with an appropriate work-life balance.

> *"After that, I knew how much work I have, when I have to finish it, I would prioritise my time by listing the things…to do. And I think the busier I am, the more organised and focused I am …I think keeping a diary is really useful to keep on top of tasks and what you want to achieve, to help with motivation and keep things realistic, where you are taking stock from time to time where you are. What you…have achieved… being clear about objectives and goals, breaking them down into smaller goals...This helps a lot, and then having a good work life balance." (Slaveia, lines 930-932, 1295-1302)*

Emir construed the demands upon him in terms of his own self-management, also bound up with a system of personal rewards:

> *"I try to manage myself. For example, I write everything in my notebook to release the stress. Or I say, okay, now it's 3.13, I say, until 4pm I won't think about anything except PhD. So, in this cases I try to manage myself and my time… to put a deadline for myself, for example, …by the end of today, I should be writing, let's say 2,000 words or something… And if I do, I reward myself." (Emir, lines 1166-1168, 1183-1184, 1190, 1196)*

8.4.3 Use of One Form of Technology to Limit the Effects of Another

Though it appears paradoxical, several interviewees referenced utilising technology to facilitate improved time management. In effect, this constituted a decision to hand over future decision making, for a limited duration, to externally crafted software. Monica, for example, opted to employ website blockers for specific periods of time in which she intended to work.

> *"I can…install things like website blockers on my computer…because I actually have access to my computer, so I'll install things that…block, say Reddit or Facebook or YouTube, things that I'm not going to need for my research…I will, I try to do 45 minutes of focused work… and then give myself a 15-minute break." (Monica, lines 85-87, 114, 120)*

Nicola had not used such software herself, though she was acquainted with people who had.

> *"I know people that use an app that blocks social media apps …on your phone so you can only use it at a certain time, or have to wait for few seconds every time before the app opens or it asks you, do you really want to open this app?" (Nicola, lines 1212-1214)*

Wei described the lengths some students go to in order to limit smartphone use.

> *"I know some students addict to…Tik Tok and something else…I think they can download an app to, I know in Chinese app store, they have an app that once you open that app, it will lock your phone… like after two hours, you can…use your phone again." (Wei, lines 2485-2487, 2493)*

In a less draconian manner, Slaveia spoke about an app which would help her to implement a time management strategy known as the Pomodoro Technique. In this, focused work sessions are alternated with frequent short breaks to aid sustained concentration.

> *"I think it was some websites where you put Pomodoro timer, and it does that. But there is also a cute app on the phone where, I think if you search for Pomodoro…you will find it, but you grow your own tree, or like a forest with it." (Slaveia, lines 905-907)*

These two sub-themes of self-reliance, and employing technology to combat the addictive, seductive, attractions of technology use, and its impact on well-being and working life, reflect competing philosophies of responsibility. These come with competing loci of control - one internal and self-directed – the other, suggestive of a dependence upon external means to exercise control over one's behaviour. This emerging duality or splitting of responsibility will be one of the central concerns as we proceed to contemplate what the above analysis is telling us about doctoral students' relationship to technology and the forms of subjectivity which accompany it.

Chapter 9: Integrated Discussion (Phase 1 and Phase 2)

The principal aim of this work has been to understand doctoral students' assessment of the role of technology in their study life. The key areas of analysis concerned assessment of the beneficial and adverse effects of technology on study, the role of technology in academic communication, and the identification of possible systematic differences in how students use and evaluate technology. The co-occurrence of the period of research with both the COVID-19 pandemic and the emergence of ChatGPT enabled these questions to be situated within a much broader and historically significant context.

The interviews added considerably to the understanding of several issues which the survey highlighted. Perhaps the most significant of these is the role of the pandemic in bringing about, and accelerating, a transformation in the nature of work in higher education (Fatani, 2020; Krumsvik et al., 2024; Hassan, 2025). This was observed to have produced several noticeable consequences. Above all, it produced major changes in the working routines of doctoral students, with consequent changes in their reliance upon technology, and their subjective relationship to it. These developments were not confined to research related activity, such as data collection and analysis. The pivotal role occupied by communication technology at the height of the pandemic (Ying et al., 2021; Del Rio-Chillcce et al., 2021), has seen it become embedded into numerous aspects of both collegiate activity and domestic life. As a result of this it is proposed that we are witnessing a significant shift in how doctoral students position themselves in relation to technology and how social relations in academic life are conducted. The consequences of this are likely to be far reaching. This shift can be characterised as involving a repositioning of the self in a technologically engineered social space, alterations in perceived responsibility, facilitated via tool-driven agency, decreased self-control, and engineered social isolation. How these have been brought about through doctoral students' relationship with technology will be made clear in the discussion which follows.

9.1 Development of Integrated Themes

In accord with the adopted explanatory sequential mixed-methods design (Creswell & Plano Clark, 2018), the integrated themes presented in this section, through which the major study findings are discussed, were developed through a structured analytical process that brought together the systematic quantitative features of the survey data with the qualitative data addressing doctoral students' processes of meaning-making.

In Phase one, statistical analysis (Chapter 6) identified key domains that significantly shaped study progress, emotional responses to technology, and students' experiences of digital tools. These domains included: conflicted emotional reactions and experiences with technology, challenges in self-regulation and 'digital' demands, as well as variability in technological competence and learning.

The Phase two interviews (Chapter 8) offered a deepened, contextualised and expanded examination of these domains, with additional interrogation of issues connected to artificial intelligence, subsequent to the emergence of ChatGPT after the survey had gone online. The interview enabled participants to discuss the personal, social and institutional dimensions of technology use both during and after the pandemic. The data was transcribed and subject to reflexive thematic analysis (Braun & Clarke, 2006; Braun et al., 2023). This provided insights into how doctoral students managed the stresses following the disruption caused by the pandemic, exercised autonomy and self-governance, and dealt with issues of digital overload and academic identity. The final set of integrated themes were constructed from a systematic comparison of the quantitative domains with the qualitative themes to establish points of convergence, complementarity, and difference. This enabled each of the integrated themes to be grounded in both statistical evidence and interpretive analysis. The constructed overarching themes represent the most analytically significant patterns found across both phases of the study. These cover key issues in doctoral students' experiences of technology which highlight the real influences of the pandemic and technology upon experience, alongside the recognition that the meanings of these influences are socially constructed and shaped through context, discourse and relational positioning. The five integrated themes are presented below.

9.2 Conflicted Relationship with Technology

It is evident both from the survey results and throughout the interviews that contemporary students experience a conflicted relationship with the information technology tools to hand, and that, as suggested earlier, there are both costs and benefits to the utilisation of technology at doctoral students' disposal (Bennett & Folley, 2014), only some of which are directly related to their work. Doctoral students are thus both empowered and constrained through their relationships with technology. On one hand, technology has enabled the maintenance, by remote means, of social (friendship, familial), and professional (peers, supervisors) relationships which were significantly impacted and obstructed by lockdown – as well as having enhanced efficiency in accessing academic literature, data collection, preparation, and analysis. The survey findings in particular suggest technology use has contributed significantly to students' study progress, both during the pandemic and in its aftermath. On another hand, these positive developments seem tied to a propensity for distraction, information overload, wasted time, procrastination, obstructed work, compromised well-being, potential addiction and stress (Steel, 2007; Steel & Ferrari 2013; Nayak, 2019). This was particularly evident in the Phase 2 interviews, where participants frequently expressed an ambivalent relationship with technology.

Paradoxically, the development of a range of technological tools has underpinned a simultaneous strengthening of the control which the doctoral student participants are able to exercise over their working life alongside a pervading sense that personal control of a different kind is ebbing away, undermined by an unhealthy, compulsive relationship with these same tools. This paradox is at the heart of the current proposal that a new 'technological subjectivity' is emerging. From a social constructionist stance, 'subjectivity', in the present context, is understood as an evolving position shaped by interaction with digital tools, institutional expectations and the wider sociocultural conditions (Burr, 2015; Gergen, 2020). This has been brought into being and driven by the transformed socio-technical system (Ropohl, 1999; Ankamah et al., 2018) that now resides at the heart of higher education. It is a system which has been dynamically transformed by the emergence of a technologically mediated 'reward' system of 'instant information gratification' (Oprea et al., 2021) combined with the recent widespread availability of AI tools (Yilmaz et al., 2023). Consequently, the critical realist ontology in this study recognises that these subjective positions are shaped by real underlying processes – people's engagement with technological artefacts, institutional pressures and pandemic-induced constraints.

The concept of technological subjectivity, developed here, offers an important aid to understanding doctoral students' relationship to digital technology. As discussed in this thesis, technology is often framed in terms of its functional aims, that is, what specific outcomes it is designed to fulfil, how efficiently these are achieved and the degree to which the intended outcomes are likely to be helpful or unhelpful to potential users. Directing attention to a technological subjectivity moves the focus to how students are actively changed by their ongoing relationship to technology. This refers not merely to their productivity but also to how they see themselves in terms of identity, and selfhood, and how they experience the world differently as a result of their technological engagement. This emphasis on technological subjectivity is thereby also relational. A changed perception of both self and the world has implications for how one relates to others in a socio-technical system which both serves and undermines one's intentions to act. Several interview participants spoke first hand of how they were being changed by technology. Deirdre, for example, commented on how artificial intelligence was changing the way she thought, whilst Wei observed how he could no longer think by himself even though he recognised the need to do so. These moments of reflexive awareness signal the importance of this changed subjectivity and highlight the need for a critical digital reflexivity to be cultivated, whereby students are encouraged to both recognise and examine how they are being changed 'from the inside' through their engagement with technology.

A doctoral student who spends many more hours than intended engaged in game playing or on social media – as interviewees here have reported - has not only wasted time. They are experiencing and evidencing a change in their level of self-control and self-determination, something which they are reliant upon in undertaking doctoral study. As has been argued in these pages, students' relationship to technology is conflicted on many fronts, not the least of which is this subjective sense of being in charge of one's actions.

The importance of technological subjectivity however exists beyond the individual level just described. The changes which participants referred to should not be read as indicators of individual failing but as reflections of a systematic psychological transformation which follows from people's relationship to technology. This brings with it, the need for an institutional response, not simply to guard or protect mental health – though this is important – but to encourage and promote a process of scholarly endeavour in which doctoral students actively appreciate how their relationship with technology has the capacity not only to assist them in their work but also to change the way they view both their work and themselves as members of a digitally immersed community.

Whether the extensive, routine technology use throughout academia has now become indistinguishable at a psychological, behavioural and physiological level from game playing is a subject for debate, with the further issue of whether some students are more vulnerable to it (Sahin, 2018). Referring to their own predilection for game playing one participant explicitly referred to regularly receiving a "dopamine hit." This raises the question of instrumental conditioning of students' behaviour and can be viewed in relation to the principles of technological determinism (Jones, 2001). Research has suggested a number of psychological risk factors for internet addiction, including depression (Ye, Zhang & Zhao, 2023), emotional intelligence (Hamissi et al., 2013), impulsiveness (Roberts & Pirog III, 2013), self-esteem (Sechi et al., 2021), social support (Zhao et al., 2023), ADHD (Wang et al., 2024) and personality (Kuss et al., 2013; Rachubińska et al., 2021). More work is required to establish the reliability of these findings, whether they are universally observed in different populations, and how higher education institutions might usefully respond to this knowledge.

9.3 Digital Self-Regulation: Time Management, Well-Being and Overload

Findings from Phase 1 of the study indicated that students who experienced difficulties regulating their technological engagement, through distraction, digital overload, or extensive screen time, reported lower perceived study progress and poorer well-being. These challenges in the management of one's time point to a broader problem of digital self-regulation and control and were evident in both survey and interview responses. They were strongly associated with doctoral satisfaction, progress, and wellbeing. The Phase 2 findings added further weight to these results, as participants described struggling to manage competing online demands, and dealing with an unceasing digital presence.

As noted, students' management of time can be understood both in terms of the labour-saving nature of technology, for example, reduced data processing time to complete tasks, consequent to advances in chip design and availability of memory, and the actual amount of time engaged interacting with technology. The interviews added to the impression from the survey that for doctoral students this is a dual edged sword. As well as the benefits, particularly regarding data processing efficiency, contemporary technology has undoubtedly also facilitated a loss of control, and introduced forms of stress whereby many students procrastinated, wasting time, caught in a dynamic in which technology invites and subsequently rewards users for engagement, irrespective of prior intentions, while threatening well-being and academic progress (Misra & McKean, 2000; Steel, 2007; Nayak, 2019). In these respects, doctoral students' relationship to time management is a further expression of their conflicted subjective relationship with technology. This challenge of 'managing one's time' for many can thus be considered as one of managing both the quality and intensity of digital engagement, as these impact on one's well-being.

The potential for these difficulties with digital self-regulation to produce deleterious effects on health and well-being is real. The survey data provided evidence that problems with time management were associated with poorer well-being. The pull toward repeated interaction with technological systems outside the pursuit of pre-planned work-related goals can be considered to fall within the remit of addiction (Simsek et al., 2019). The habitual resort to the use of digital technology was elaborated in the interviews, as participants cited multiple avenues to compromised well-being – conforming to Savci and Aysan's (2017) mapping of internet addiction. These included the lure of social media use, game playing, the constant search for news, the effect of misinformation, and the danger of unfavourable social comparison with others. Participants readily admitted to relishing the "hit" obtained in the course of hours of game-playing, the continual checking of smartphones to "see what's going on" and foregoing opportunities to engage face-to-face with others. In their capacity to gauge how mismanaged time could interfere with work, the interviews functioned as a richer, more sensitive barometer than the survey.

The findings are consistent with work which suggests doctoral students working in digital environments require significant self-regulatory skills (Azevedo et al., 2018). It is imperative that they are situated in the broader context of the COVID pandemic – in which many participants reported feelings of loneliness and isolation. The relationship between technology use and loneliness appears to be complex. On one hand, the discomfort produced by isolation may have been a factor propelling students to engage further with technology with an intention of distracting themselves from their feelings, while excessive technology use itself can also contribute to feelings of loneliness (van Tonder et al., 2023). In addition, doctoral students may also have turned to electronically mediated communication to connect with others and allay their feelings of isolation (Balki et al., 2022) with the added prospect of human contact functioning as a digitally mediated social reward shaping addictive behaviour (Wadsley et al., 2022). These distinct relations, entailing distinct types of technology use, rooted in distinct motivations, may even be considered as constitutive of contemporary postgraduate culture.

It is vital that research unpicks the determinants of social media and other forms of technology addiction in doctoral students as well as identifying who is most vulnerable. In a recent study of over 400 PhD students, He and Zhu (2024) reported academic stress was positively correlated with social media addiction, with this being in part mediated by anxiety. To what extent technology addiction affects PhD completion rates and completion times is currently unknown but research on this is clearly needed and carries implications for the type of support offered by institutions to their PhD students. The potential effect of widespread addictive technology use on PhD progress and completion, and student mental health, in addition to the challenge of generative artificial intelligence raises several serious challenges which, at present, higher education institutions have yet to adequately address. Institutional policy must be active in acknowledging that computer technology is not value-neutral but can either advance or hinder doctoral work depending on circumstances and how it is used. As such, while students' coping skills and mechanisms may be potential points of intervention, these alone do not entirely address the nature of the difficulties.

9.4 Training: Self-Governance, Technological Competence & Informal Learning

On top of the conflicted nature of technology use and the benefits and drawbacks incurred through it, further concerns have been brought to attention. The rapid nature of the cultural change in technology use has been commented upon, and it is therefore not surprising that any guidance or training necessary to operate effectively in the transformed higher education eco-system has lagged behind. Many of the respondents reported learning digital skills independently or through peers rather than through formal provision. During the interviews, the students frequently referred to themselves as being 'self-taught', with informal learning often the default expectation. The shift to remote learning as a result of the pandemic arguably accelerated the pattern of self-reliance. The relative absence of training, noted in the survey is consistent with previous findings (Tsatsou, 2016; Gouseti, 2017; Mireles et al., 2018). This was discussed at greater length in the course of the interviews where an evident need for it was raised by several of the doctoral students, even as a majority of them took pride in being largely self-taught in their technological skills. This was the case even when it came to the specialist software that was of primary importance for some of the participants in carrying out their research. As specific forms of software – videoconferencing and generative AI for example – have assumed greater importance over the course of the period in which the study took place, the findings gave no indications that institutional awareness of the need to provide systematic training had changed. There may be several reasons for this. One possibility is the expectation that postgraduate students are expected to be independent and self-motivated in conducting their studies. Traditionally, this expectation has been fostered in an environment in which supervisors already possess the skills the doctoral students are in the process of acquiring. However, in an age of rapid technological development – witness the use of video conferencing and ChatGPT, this environment can no longer be assumed and thereby the needs of the students and the support they require, will have changed with it.

There may be an additional reason for universities remaining unaware of the need for training provision – and this may owe something to the multiple crises which have enveloped the higher education system in recent years – notably in the areas of finance (Universities UK, 2024; Xia, 2025) and student mental health (Campbell et al., 2022; Lui et al., 2024) – and which have undoubtedly absorbed the attention of higher education managers.

Each doctoral student is expected to regulate their own learning and create opportunities to meet their anticipated need for training and advancement. In this it must be remembered that a sizeable minority of participants experienced difficulties in learning and using software and may be ill-equipped to meet all the technological challenges they encounter. How higher education institutions respond to this has the potential to affect large numbers of doctoral students and could potentially be a factor in whether they continue to pursue careers in academia or drop out. With regard to the question of formal training versus self-teaching, students' engagement with technology, their reliance upon their own ability and their sustained motivation, can be seen as grounded in two factors. The first of these is the necessity for self-directedness and independence – qualities essential to doctoral level work; the second is the relative absence of responsibility exercised by institutions to provide training.

Whether or not self-reliance is understood as an 'intrinsic' strategy adopted by individuals or as a necessity imposed upon them, consequent to institutional expectations or inaction, the significance of self-governance (Heikkilä, & Lonka, 2006; Zhoc et al., 2018), and its preeminent place in contemporary capitalist societies is indisputable. It forms a core ideological element in which the self is positioned not merely as the imagined source of agency, wealth creation, innovation and entrepreneurship but also, and increasingly so, as an object of surveillance – both by oneself and external agencies.

How the advent of AI affects the social construction of responsibility - whether in moral, practical, or hermeneutic terms (Coeckelbergh, 2023) is a matter of substantial and growing importance. Doctoral students are in many ways situated at the forefront of this unanticipated and unfolding dynamic reconfiguration of the 'technological' self. It is of some interest that relatively few participants, either in the survey or during the interviews, expressed any concern about the creeping surveillance and invasion of privacy which has been a partner of technological innovation. As mentioned earlier, this may change in the future, but the relative absence of concern/discussion by the participants is noted. Whether this lack of concern is itself related to the level of their technological engagement, or a reaction to the rapid technological and social change of the moment, or a product of the "connected individualism" (Flichy & Carey-Libbrecht, 2004) fostered by the culture of technology could be addressed in future research.

Surveillance and the interrogation of self-governance together occupy a cornerstone of Foucauldian analysis (Rabinow, 1991), which theorises the proliferation of 'technologies of the self'. These refer to a set of culturally and historically situated regulatory practices – self-care, self-reflection, and self-discipline – to which can be added – 'self-teaching', which, intentionally or otherwise, functions to modify the self rather than the external environment. In doing so further weight is added to a socially constructed milieu characterised by increasing levels of social isolation. The observed recourse to self-regulation, which doctoral students here have openly favoured, in the face of challenges posed by new technologies which threaten to upend their own self-control, can be viewed not only as a paradoxical consequence of existing social, political and technological forces but also as a driver toward yet further dependence on the self.

Where this dynamic will lead is open to speculation. The long-term effect of the technical reconfiguration of the self in academic life can be expected to have repercussions on identity and the nature of community. At present, it heralds an industrially propelled change in people's relationship to themselves, (and by implication their relationship with others) whereby developments fashioned by increasing external power come to be culturally reconfigured in terms of an imposed necessity to uphold individual autonomy and responsibility. This process can be interpreted as one consistent with a species of technological determinism (Jones, 2001; Wyatt, 2023), although this would be far from providing a complete picture. Choice, how it is exercised, and in what directions, is also an important element in the transformed socio-technical systems of higher education (Long, 2018). Why actors within a system ultimately choose to apportion their own self-control to the demands and dictates of a machine imperative lie beyond the scope of the present work. What one may say, however, is that in any final accounting, the balance of *perceived* benefits and detriments accrued from engaging with technology, and the factors which shape these acts of sense making, must find a necessary, if incomplete place, in any overall explanation. How individual this process of accounting actually is, cannot yet be assessed.

In comparing students' responses to the transformative impact of videoconferencing and generative AI on higher education, it is evident that the effects as well as the consequences of their use differ substantially. Because of these differences, each technology carries different implications for self-reliance and need for training which one would expect to cover not just how to efficiently exploit the potential of each tool but also address the potential risks and dangers associated with their use. In the case of AI, the attendant risks – as indicated by participants' remarks in the interviews, are considerably greater.

None of those interviewed referred to videoconferencing as a disruptive or problematic influence, although the risk of zoom fatigue is well documented (Cranford, 2020; Duffy, 2020; Bailenson, 2021; Lee, et al., 2022). The technology itself is not new, although the situation that magnified the need for its use – the arrival of the pandemic – most certainly was. Adaptation and rapid self-learning of the available tools (Teams, Zoom, etc.) in this sphere has not been unduly problematic (Camilleri & Camilleri, 2022) and can be compared to the challenges inherent in learning any piece of software judged necessary to one's work. This situation can be contrasted with the upheaval wrought by the rapid introduction into the public and academic domain of generative AI. The changes accompanying this technological moment have been of a magnitude that institutions are struggling to adapt to the consequences, some of which may require still more time before they become clear (Moorhouse et al., 2023; Freeman, 2025).

These findings imply that doctoral digital competence cannot be viewed solely through a deficit lens or as an institutional failure. Rather, it reflects a complex interplay between student agency, institutional resources, the pandemic context and evolving expectations of digital scholarship.

9.5 Artificial Intelligence

Amongst the problematic aspects of technology use, the arrival of generative AI, principally in the form of ChatGPT has loomed large. In the interviews participants spoke at some length of a range of novel problems they had encountered - practical, empirical, legal and ethical - stemming from its use. All these problems, which the analysis organised into distinct sub-categories/themes, pose fundamental challenges to higher education. Two of them –the technology's environmental footprint, and the assault from major technology companies on intellectual property rights - cannot as yet be said to impinge, either directly or immediately, on the day-to-day conduct of doctoral research work. With regard to the environmental and energy footprint of AI use, it has been estimated that the power consumption of a single ChatGPT enquiry exceeds that of a traditional Google search by a factor of ten (de Vries, 2023). Educational institutions will need to address this issue as both AI use and climate change awareness continue to grow. Sustainability is recognised as being of strategic importance in higher education (Khan et al., 2025), although there is currently no clear evidence that the energy consumption of large language models utilised by researchers – and by undergraduates - is being factored into institutional policies on sustainability, even as universities develop new guidelines and recommend the integration of AI into existing curricula (McDonald et al., 2024). A recent survey of full-time undergraduate students in the UK indicated that use of AI by them has mushroomed, with the percentage reporting use of any AI tool jumping from 66% in 2024 to 92% in 2025. The same survey reported that only 36% of students had received training in AI skills from their institution (Freeman, 2025). One reason for this may be that academic staff are also struggling to understand the nature of AI tools and the implications they carry for teaching, assessment and research in higher education.

The further two subthemes mentioned by respondents have an undoubted impact on the conduct of research work. Concerns about the accuracy and reliability of ChatGPT output – for example the production of 'hallucinated' references - have been documented by many researchers (Vaishya et al., 2024; Xu et al., 2024; Schei et al., 2024). Furthermore, worries have been expressed about the effect of repeated use of ChatGPT on students' creative capacity (Farrokhnia et al., 2023; Das & Madhusudan, 2024). The work by Niloy et al. (2023) suggests such fears may be well-founded. The researchers employed a pre-and post-test design to compare the creative writing skills of 600 students drawn from ten universities. With students allocated either to an experimental group (exposed to ChatGPT) or a control group, significant decrements in four dimensions of creative writing skills were observed in the ChatGPT group. The Student Generative AI Survey (Freeman, 2025), referred to above, which found that half the students had made use of AI to produce research ideas, also provides grounds for concern. In further work by Liu et al. (2024) use of ChatGPT, even in expressively creative tasks, led to the production of increasingly homogenised contents. While these early results have yet to be replicated, and it is recognised there are several distinct aspects to creative performance, some of which may be unaffected by ChatGPT use, the early signs of a negative effect are concerning. A further concern, and one which may be more subtle, is that excessive or long-term use of AI may not just impede the creative reasoning of researchers, and limit the type of research questions asked, but redefine academic identity in ways which signal a subordinate relationship to AI.

Viewed from a social constructionist perspective, the concerns expressed are symptomatic of a change in how doctoral students position themselves in relation to emerging technologies that directly impinge on the processes of knowledge generation. These changing constructions are responses to systems that have real, observable effects, pose genuine risks and exert specific constraints on doctoral practice, while at the same time lacking in accountability (Binns, 2018).

More work is thus clearly required to understand the potential long-term consequences of AI use, and the type of AI use employed in different disciplines. Currently, such work is in its infancy. While such work will take time, the issues raised by doctoral students in the present study call for an institutional response in the near future – not only in alerting students to the possible dangers, but also in attempting to mitigate these through new forms of training and guidance. Such initiatives are likely to assume increasing importance in the future development of higher education (Barbas, Viera & Branco, 2023). It can be argued that 'AI literacy' must attend to formal technical mastery of the tools, as well as the ethical implications of AI use, and the intellectual, psychological and psychosocial dimensions of technology use. This brings us to the next theme to consider.

9.6 The Human Element in Technology Engagement

We have seen students are very appreciative of the benefits which technology brings to academic life. Nevertheless, in distinct ways, both the survey and interviews drew attention to the importance of the human dimension to doctoral study. In appraising how people engage with technological systems and how they interpret that engagement, the interviews, in particular, can be said to have raised questions regarding the bounds which this places on human-machine interactions.

The survey highlighted the importance of the human element in several ways – all of which lie outside the usual scope of ergonomics. These include an expressed preference for face-to-face contact in campus education, students' belief in the importance of direct, unmediated relationships with other people, and the nature of emotional engagement, positive and negative, with technological systems and with peers. All of these issues have been illuminated by the impact of the pandemic on doctoral study. The paramount role of human agency in all these aspects points to limitations in any account of technological determinism, as well as suggesting there exists an inherent resistance to a digital domination of higher education. These forms of relational engagement constitute socio-cultural processes

(Wenger, 1998; Wertsch, 1998) and suggest that human relationships are foundational, even within a heavily technological environment. Given this, the views of doctoral students collected here, in principle, could make a useful contribution to debates on the future development of technology policies in universities. At present, public discussion of the consequences of the technological revolution has focused on the capabilities of the technology, and how this is understood (Miller, 2022) and somewhat less on the experiences of users and how people are making sense of the technology. The current work represents an important counterbalance to this, although much remains to be done.

Substantive evidence of the importance of the human dimension to technology practice emerged from the interviews. A particularly significant comment was made by one of the participants, who judged that remote working had exercised a detrimental effect on the sense of community in academic life. Another remarked on the loss of vital non-verbal information in digital exchanges. Although the comments were brief, their significance is considerable. With higher education institutions in many countries experiencing serious financial challenges, the attraction of further automation in a quest for cost cutting carries risks for the social cohesion and practice of community in academic life. If technology develops and is utilised in such a way as to subsume previously accepted social and intellectual functions – which Berry (2017) has viewed as fundamental to education - the academy as we know it may eventually become unrecognisable. While existing literature has pointed to the possibility that technology use by students can enhance the sense of belonging to a digitally connected community (Ramayah & Amin, 2015; Shan & King, 2015), the advent of generative AI threatens to upend established traditions, norms of conduct and methods of communication. If scholars move from a mode of communication in which feedback is primarily acquired, not from interacting with other scholars but from digital exchanges with an impersonal and de facto agentless AI system, the very notion of collegiate inter-subjectivity comes under fire. This can be expected to have extensive structural repercussions regarding what kind of community scholars believe they belong to. Even as AI develops and its output increasingly resembles that of a human interlocutor, there will be legitimate questions about the type of 'inter-subjectivity' which is being nurtured in human-machine interactions. A potential outcome is that Lave and Wenger's (1998) community of practice may well be threatened, a conclusion more drastic than Zhu and Procter's (2015) reservations on the role of technology in it.

As described earlier, the community of practice framework proposes that critical scholarly thinking needs to be socially engaged and embedded within and beyond existing knowledge frameworks. While interpretations of the meaning of a community of practice have been varied (Li et al., 2009), central to it are issues of academic identity, personal development and an ongoing tension between the individual and the organisation (Ching, 2021). This mutual bond between the individual and the institution, which is in part mediated by relationships with peers, and supervisors, must now however make way for a quasi-agential third party – the AI engine and its corporate sponsor. The introduction of this external ‘agency’ may bring with it the imposition of corporate or ideological goals external to the situated academic community – a danger that is perhaps more elevated in the social sciences where models and theories may be more contested than in the natural sciences, and indeed where questions of power are more likely to be interrogated. Trust is central to public acceptance of technology (Durant et al., 2005) and holds a key place in academics’ relationship to it. Li et al. (2009) referenced the importance of high levels of trust between community members, but if human co-creation and engagement are increasingly replaced by a hybrid human-AI system of interaction, there can be no possibility of genuine reciprocal trust and if any residue of ‘trust’ exists it must perforce be one-directional and alienated, turning on a degraded belief in the functional reliability of a machine lacking in intentionality.

In relation to AI, no existing system can be said to possess the requisites of human intentionality – subjective awareness, conscious awareness of intentional objects, semantic grounding (Dennett, 1989) and situated embodiment (Varela, Thompson & Rosch, 1991). What this means is that Studebaker and Curtis’s (2021) advocacy for a ‘cohesive community’ for doctoral study, aided by an intentional structured programme of instruction, in the footsteps of Vygotsky (1962), may be undermined. There was little evidence of it in the accounts given by interviewees, where most participants appeared to be engaged in what was largely a solitary pursuit of their own research goals. Furthermore, the potential retreat of critical thinking promulgated by dependence on AI, as well as a potential narrowing of opinion (Su et al., 2022) needs to be taken seriously if existing community cohesion is to be preserved in the short term yet also maintained for the foreseeable future.

A strong indication that the new technology is posing challenges to a vibrant and cohesive scholarly community is the widespread sense of isolation reported in the interviews, which was undoubtedly exacerbated by the pandemic (Holt-Lunstad, 2021). This has been previously documented (Lovitts, 2001) and noted as a potential factor hindering success in online and distance learning programmes (Chang & Bryan, 2020; Rasheed et al., 2020; Studebaker & Curtis, 2021).

Given the growing use of technology, there remains the possibility that the distinction between what is technically full-time, on-campus study and what is technically distance learning or online study is no longer as clear cut as it once was. This arguably stems from the fact that in both scenarios students are spending a significant portion of time sitting in front of a screen, socially disengaged from others, and subject to the addictive dynamics of digital life. How far doctoral students now tend to interact with other members of the scholarly community – peers, supervisors, and other academic staff – primarily through videoconferencing and instant messaging rather than in person, requires further data alongside consideration of what the psychosocial and scholarly effects of this are.

At present little data exist regarding the effects of the pandemic on the social skill set of postgraduate students. There is, however, growing evidence that in younger children the accompanying reduced social experience and isolation, increased screen time, and disruption to routine, has led to socio-developmental deficits such as delayed language development, impaired communication skills, heightened anxiety, sensory sensitivity, social withdrawal, and repetitive acoustic and other behaviours that resemble autism (Bayley, et al., 2023; Cattan et al., 2023; Scott et al., 2024). The possibility that technology dependence may produce responses in users that resemble autistic traits provides a further avenue through which the practice of community in academic life may be impaired and raises for consideration what kind of interventions or training may impede or reverse these effects.

Two further concerns are pertinent to any consideration of the human dimension to technology use. The first of these is the emotional nature of technology engagement. We saw, from the survey data, the significance of this for doctoral students' well-being and study progress, but the interview data, particularly regarding the negative evaluations of technology use, have also added weight to the contention that the 'emotional useability' of technology (Shih & Liu, 2007; Saariluoma, 2020) cannot be neglected. In many ways this underpins the entire evaluative edifice of students' approach to and understanding of technology and their relationship to doctoral study. As stated, doctoral students approach technology, with all its putative benefits, through the legacy of their own personal histories, motives, and capabilities, and it is these which inform how it is appraised and utilised, effectively or not. This multi-dimensional emotional landscape encompasses a great deal more than the putative binary opposition between frustration and competence (Saariluoma & Jokinen, 2014) and needs much greater appreciation if both individuals and institutions are to effectively ride the wave of the technological revolution sweeping through the corridors of academia.

The second concern is to do with how remote or long-term digital working affects the shaping of identity, whether this is individual identity, a social identity forged within a research group of nascent scholars, or an institutional academic identity. From a social constructionist perspective, doctoral identity and subjectivity are shaped through the relational encounters students have with others. How students eventually position themselves is a product of interactions with supervisors, peers, the wider scholarly community and of course, with technology (Burr, 2014; Gergen, 2020). From a realist vantage point, these interactions matter and engender effects on motivation, commitment, career aspirations, and study progress. How isolation is experienced in one's work may contribute significantly to identity. A crucial matter is therefore how an academic identity, shaped to a large degree online, is constructed and 'performed' (Gergen, 2000; Bennett & Folley, 2014; Koole & Stack, 2016) in relation to other scholars. Hollings (2021) contends that the formation of students' specific identities is affected not only by the location of the university in which they are situated but also by the nature of the policies pursued there. According to the prestige of the institution, these may narrow or enlarge the horizon upon which students project or imagine their academic futures and vary in the degree to which they are securely held (Halliwell & Limpus, 2025). They may also have a defining role in how students position themselves, interpersonally, locally and internationally, in academic social spaces which are subject to the influence of systems of power, class, community and history (Fotovatian & Miller, 2014).

In the contemporary neoliberal university, where image, reputation and league table position are paramount, alongside an endemic precarity (O'Brady et al., 2025), the degree to which students align themselves with institutional goals may comprise a facet of their academic identity (Troiani & Dutson, 2021; Nordbäck et al., 2022) as well as shape the goals they pursue within higher education and the values with which they pursue them. It was noted that amongst the present interview sample, almost all had employed work and study strategies which were individualistic, tied to a mantra of self-reliance. But the importance of such self-governance (Heikkilä, & Lonka, 2006; Zhoc et al., 2018) extends beyond issues of individual well-being. If the experience of study across the sector shows signs of becoming a less interpersonal one, rooted in the imprint of technology, and marked by social isolation, then the cohesiveness of the academic community itself, and with it its ability to resist potentially hostile forces, may be significantly impaired. Today, real threats to academic integrity are in the air, with fears expressed about the erosion of academic freedom throughout Europe (Maasen et al., 2025) and serious attacks on education and research in the US (Webb & Kurtz, 2022; Witze & Kozlov, 2025).

Given the list of threats which have been outlined– the need for systems dedicated to training and support for doctoral scholars oriented to how they understand and engage, both emotionally and socially, with technological systems is evident (Chang & Bryce, 2020). Whilst all students have specific individual needs, there is a systemic necessity to provide up to date dispassionate information about not only the benefits of technology but also the potential risks and dangers, in the short and longer term. This must come on top of institutional support to enable users to make optimal, well-informed decisions about how to engage with technology as well as where to turn for assistance, whether that assistance is practical or emotional.

An important question for the future concerns how volatile the observed social, emotional, cognitive, interpersonal and practical relations which students currently enjoy with technology will prove to be. In an era of rapid change, stability cannot be assumed. In the Postgraduate Research Experience Survey (Neves, 2023), marked changes in the extent of in-person communication over the period 2021-2023 were observed, with a tendency for personal contact to be associated with significantly greater satisfaction levels. This chimes with the thrust of the findings from the present study regarding how highly valued personal contact was. Although in-person contact increased over the period of Neve's survey, there is little prospect of a return to pre-pandemic levels. From this, one must conclude that as well as an unparalleled technological shift there has been a corresponding shift in the interpersonal dynamics present in higher education, and that this is likely to set new norms.

9.7 Summary

In this chapter findings from both phases of this explanatory sequential mixed-methods study, have been brought together to reveal the interdependence of the objective and subjective dimensions to doctoral students' engagement with technology. The themes discussed above, reflect the interplay between real structural influences, for example increased digital demands, institutional expectations, the effect of the pandemic and the introduction of ChatGPT, and the socially constructed meanings through which the students interpret their experiences. Many of the issues raised in this chapter – students' conflicted relationship to technology, problems with time management, self-regulation and training, as well as the revolutionary impact of artificial intelligence - need to be understood in relation to doctoral students' situated relationships in the higher education system. This situatedness encompasses both the institutional, technological environment in which they study, and the human dimension to that presence. The enormous changes precipitated by COVID-19 and the development of AI suggest that as we move into the future there is little that can be taken for granted in doctoral life. Understanding the complex interplay between the digital and the human dimension to life in the post-pandemic culture of higher education provides a foundation for the implications, recommendations and conclusions set out in the final chapter.

Chapter 10: Conclusion

10.1 Concluding Comments

This study set out to investigate how doctoral students employ digital technologies in the course of their studies; to discern identifiable patterns in this use and to document the range of beneficial and adverse effects which they perceive. Particular attention has been given to communication, study progress and well-being. An explanatory-sequential mixed-methods design utilising a cross-sectional survey and in-depth interviews was adopted to answer these questions. The data revealed by the research has been interpreted within a social constructionist framework – with due regard to socio-technical and socio-cultural considerations. This has emphasised the meanings attached to technology use in the context of the COVID-19 pandemic and the emergence of new technologies. In the discussion which follows, the principal conclusions and limitations of the work will be addressed. These conclusions must be understood in the context of the study's philosophical orientation. They reflect the assumption, grounded in realism, that institutional and technological structures exert real effects on doctoral students, acknowledging at the same time the constructionist view that students seek to make sense of those effects, and do so through interaction, discourse, culture and context. The thesis will conclude with a set of recommendations based on the findings, with final reflections on key issues in the conduct of the work.

The integrated findings reviewed in the previous chapter highlight several key themes. First, doctoral students demonstrated a conflicted relationship with technology, valuing its efficiency while at the same time expressing concerns about overload, distraction, emotional cost and dependence. Second, the study revealed that what may often be considered under the rubric of "time management" may be better understood as self-regulation in a digital context. Third, technological competence is acquired primarily through informal self-directed and socially mediated learning. This points towards the resilience and adaptability of doctoral students. Fourth, engagement with artificial intelligence was characterised by concerns about accuracy, ethics, academic integrity, with implications for scholarly identity. Finally, in the context of extensive digital immersion, doctoral students repeatedly stressed the value of human connection, in influencing their well-being, work motivation and sense of identity. The following section considers how the research addressed the research questions with which this study began.

10.2 Research Questions

Research Question 1: How do doctoral students employ digital technologies to research literature and collect data? Are there systematic differences in how students use and evaluate technology?

There is little doubt that technology occupies a pivotal position in the working and personal lives of today's doctoral students, its importance magnified by two factors: the transformative effect of the pandemic and the introduction of the latest tools in generative artificial intelligence. The technologies utilised ranged from videoconferencing technology and communications media to digital libraries, data analysis, transcription, reference packages and specialist software. This technology was deployed throughout the research process — from sourcing relevant literature to data collection and analysis.

Research Question 2: What perceptions do students have regarding the beneficial and adverse effects of technology on their study tasks?

Hugely beneficial though it is, technology was construed as bringing in its wake many serious challenges. As well as disruption to economic and occupational stability, these challenges appear inextricably bound to the technology's psychological and social impact. Whilst participants were unanimous in stressing the beneficial contributions of technology to their study, these benefits were laced with ambivalent and conflicting sentiments. Digital tools were frequently seen as producing information overload, distraction, poor time management and potential addiction. These were accompanied by issues of poor well-being, stress and isolation. The participants raised the importance of support and training to deal with the adverse effects and to maximise the potential of the technology. Students' individual struggles need to be situated within a wider biological, institutional and technical context. A range of potential and actual problems were referenced and discussed in the context of the pandemic, institutional and technical constraints as well as the increasing shadow cast by artificial intelligence, not just on individual students but also on what might be conceptualised as the 'higher education technology ecosystem' with issues of sustainability to the fore.

Whether the context is viewed in terms of a technology ecosystem or an ergonomically driven, dynamic human-machine activity system (Baxter & Sommerville, 2011; Uden & Ching, 2024), there are several substantial unresolved issues for present and future students, as well as higher education administrators and policy makers. These include not only the question of how to satisfactorily co-exist with machines, but also of how to ensure that human beings thrive and remain masters, rather than hijacked spectators, of their fate. The intellectual and psychological drive to interact with technology, including the documented compulsive dimensions to this use, coupled with an instinctive, institutional commitment to AI, prior to any comprehensive appraisal of the pros and cons of doing so, suggests that technology, embraced by the participants of this study as both necessary and problematic, may already be subject to constructions which depict it as driven by a momentum, which eludes human control.

But if one side of the equation of technology use is engraved with inevitability, compulsion and reduced agency, laced with the ostensible benefits of remote working and enhanced productivity, then the other side delineates the contours of a form of resistance, albeit one moulded in the ideological cast of individualism. A key task for users in future will be to extend the scope of this resistance beyond actions that any one individual may choose to take as they seek to build a life and career in academia. The issues of who controls this technology, by what means, and with what transparency in decision making, constitute profound challenges, for individuals, for higher education institutions and for society.

Doctoral students in many ways stand at the forefront of the technologically driven cultural changes we are witnessing. An ongoing task, as this change unfolds, is to comprehend how technology users frame their own understanding of the digital environment in which they study (Dange, 2010), and of the practical and psychological connections they develop with tools which, one hopes, are intended to serve them - and to keep track of these in parallel to ongoing technological innovations. To that end, the present research is an important step in establishing the contours of doctoral students' relationship to technology, and how their work, social relationships and well-being are affected by it.

Research Question 3: Are there identifiable patterns of technology use in diverse settings that differentiate those who feel productive from those who do not?

The survey data revealed that satisfaction with study progress was predicted by variables which assessed technology use and emotional well-being. As indicated, the findings are consistent with both the socio-technical and socio-cultural conceptual models of human interaction with technology. Of particular interest, data pointed to increased study satisfaction during the period when pandemic restrictions were in place, when the predictive power of the model was greater. Besides significant increases in the effect of the pandemic on study, the pandemic period was also marked by greater preference for digital access to literature, as well as greater sleep disruption due to online study. The findings are consistent with changed study patterns, a shift in work-life balance, and a greater reliance on technology during the pandemic. The data certainly demonstrates the adaptability of doctoral students, but does it hold any lessons for how students engage in relatively ‘normal’ periods? The answer is yes, if we view the pandemic as one amongst many possible means by which normal patterns of social and working life may be subject to major disruption, conditional on the functioning of a digital infrastructure.

Another striking observation was that there were few significant effects for demographic variables on study progress, well-being or in patterns of technology use. There was no evidence of the gender imbalances in work-life balance due to the pandemic which has been reported elsewhere (Anwer, 2020; Sahni et al., 2023), although that should not be read as a definitive rejection of the possibility that none were present. The demands on doctoral students, however, cannot be assumed to be identical to full-time tenured staff where such differences - in productivity for example - have been documented (Anwer, 2020). Where differences were noted – in patterns of data collection between science and non-science students for example, or between full and part-time students - these were likely due to the varying academic demands placed on the students.

Research Question 4: To what extent does technology facilitate or hinder effective communication with others, including fellow students, teachers, and supervisors? For example, do students prefer face-to-face feedback or feedback mediated through technology?

As we have seen, communication between doctoral students and their peers, and supervisors – as well as with their friends and families was profoundly affected by the pandemic, with technology playing a key role in this. Overall use of communication technology was extensive, with videoconferencing with peers, though not with supervisors, positively correlated with satisfaction with study progress. Further work will be required to understand what lies behind this. One may reason that the informal nature of the communication, parity in status, shared experience, emotional ties/friendship and motivation may be responsible - suggesting firstly, that psychological rather than academic/intellectual properties of the relationship may be critical and secondly, that videoconferencing, via the provision of real-time interaction, with visual and auditory, non-verbal communication is better able than purely text-based messaging to facilitate a sense of presence, shared time, trust and emotional support. This is consistent with evidence supporting the role of videoconferencing in mental health provision (Donaghy et al., 2019; Sugarman & Busch, 2023).

The communication of support and provision of training play important roles in doctoral education. How best to communicate available support and assistance to students who have different academic and emotional needs may require further reflection as well as further research, although it is to be hoped that the temptation to employ automated systems to deliver it will be resisted. The endeavour could draw upon the model of technology adoption (Vallade et al., 2021), which can be considered a variant of social cognitive approaches, although these suffer from several serious methodological, as well as theoretical limitations (Ogden, 2003; Sheeran et al., 2013; Sniehotta, et al., 2014; Billig, 2019). Ethical considerations, regarding student expectations, and potential outcomes must be foremost in the planning and implementation of provision. The benefits of videoconferencing suggest that in principle remote provision of training and support could be effective.

10.3 Policy Issues

If communication is more broadly framed to include that between doctoral students and their host institutions, then the relationship between technology and communication must include the question of how the views of doctoral students inform the development and implementation of an institution's policy on technology. For this to happen it is vital that they are consulted and are in a position to participate in decision-making processes affecting them. Surprisingly, only one participant interviewed raised the issue of consultation with doctoral students about the technology options available for them. There is, as yet, no indication that students throughout the sector have been widely consulted, although a desire for clear policy and guidelines for technology use is certainly widespread amongst them (Johnston et al., 2024).

Acknowledging the momentum behind technological progress and accepting the evidence that this 'progress' will likely entail negative consequences, means there is a collective, social imperative to ensure that any actions taken are not informed by a contemporary form of 'Luddism' directed toward the abandonment or rejection of technology. To state this is not to suggest that parallels cannot be drawn between the early automation which characterised the first industrial revolution, with its attendant fears of job displacement, economic anxiety, and loss of control, and the digital revolutions of today (Earnhart, 2024; Nichols et al., 2025). In deciding how to respond to technological developments, research has a role to play - in both developing our understanding of the technological transformation of life – in the present context, doctoral education - and in establishing how users can most fruitfully adapt to it. In evaluating outcomes, attention to human well-being must be accorded some priority. How to fulfil this aim, and when to decide well-being is being compromised is as much a philosophical and moral question as an empirical one.

10.4 Limitations

Like all research, the present work was subject to some limitations. Recognition of these is necessary for the appropriate understanding of the results and the context in which they were gathered. The limitations present should be placed in the context of the methodological, conceptual and contextual decisions made, given the critical realist ontology and social constructionist epistemology which underpin the work.

10.4.1 Contextual Limitations

The survey and the interviews were intended to cast light on the study habits of doctoral students, the relationships they have with technology, the role which technology plays in their learning and the constructed meanings which suffuse and underpin the technological realm. At best the data can be read as providing a momentary snapshot in the midst of an evolving interdependent relationship between humans and technology. The survey and interviews together highlighted issues which arose in the immediacy of the pandemic and post-pandemic period. These responses could be indicative of transient states of adjustment, but at the very least they provide evidence of resilience and digital adaptation. Whether the putative causal relationships suggested by the survey analysis prove to be enduring, of necessity, will require further empirical confirmation, more so given the unique combination of circumstances which spanned the period over which data was collected. This period - the pandemic and its immediate aftermath - in tandem with the 'revolutionary' introduction of generative AI, stands as a watershed moment in the history of the relationship between humans and technology and in the development of higher education. The arrival of ChatGPT on the scene came after a considerable number of survey responses had already been completed. Late additions to the study were therefore made to capture important data on this, but it remains a limitation that a considerably larger set of data may have enabled more substantial analyses of the correlates of AI use and its evaluation by participants (Akbar, 2025). Nevertheless, issues around AI use were extensively explored in the interview phase of the study.

To what extent the technologically salient events of the recent past have permanently transformed the relationship which doctoral students have with technology cannot be said with certainty. The question of whether there has been a fundamental realignment in the nature of the gains and losses entailed by technology use - both psychologically and in relation to academic productivity - will no doubt become clearer in the course of future empirical work. However, even before we think about the effects of artificial intelligence, what is clear from the participants' data is that the arrival of new technology has permitted new kinds of research questions to be posed and answered. For example, the world wide web and videoconferencing have opened the door to new means of data capture and interrogation, whilst enhanced computational power has enabled virtual realities to simulate aspects of the real world and answer questions about the effects of environmental inputs on targeted systems.

In line with the above comments, the interviews offered evidence of a technologically induced disruption in postgraduates' lives. Notably, they point to a marked shift having occurred in the mode of participants' relationships with themselves and with others. This probably owes more to the extensive adoption of social media and utilisation of generative AI than the move to videoconferencing which followed the pandemic. In recent years, the function of technological instruments has shifted from serving a primary purpose as tools for the achievement of work-related goals towards becoming objects of affectation and attachment, which now govern and shape broad areas of human behaviour and well-being. Thus, it remains unclear whether doctoral students will regain some degree of equilibrium in their relationship with technology the more accustomed they become to emerging technological norms or whether the relationship they have will move in the direction of increasing dependence. This raises further questions about whether and to what extent the patterns of technology use of academic staff and the meanings they employ differ from those of their students. Should marked differences exist, these may well carry implications for postgraduate study and supervision. Finally, while the findings cast light on how doctoral researchers negotiated the technological, emotional and social consequences of the pandemic, they should not be read as representative of all doctoral students or of all the institutional contexts in which doctoral study is carried out.

10.4.2 Methodological Limitations

A) The current data, given its cross-sectional nature, provides an overview of each participant at a single moment in time. In their favour, the data were gathered from a substantial and widespread student base, providing some confidence that the picture which emerged can be considered broadly representative of students across a wide range of academic disciplines and locations. Nevertheless, it must be acknowledged first, that participation may have been slanted in favour of students more comfortable with digital technology; secondly, that participants were studying at different universities, with variation in policies, infrastructures, and support networks. This institutional variability could have acted to accentuate or attenuate relationships between key variables in the study – for example putative relationships between study progress and time management may vary by institution dependent on the local policies followed. Hence some caution is necessary in how the results are interpreted. The ecological fallacy is relevant in this regard. The pattern of survey findings characterises the sample as a whole and should not be read as characterising any one locality. As noted in the methods section, separating participants into science and non-science groups allowed some disciplinary variation to be captured in the analysis. However, the study's design did not allow for a deeper examination of differences between individual disciplines.

B) Self-report measures have been utilised throughout the current research. As indicated, these are widely employed in survey research. Where these concern inherently subjective states, such as emotional reactions to technology use, they may be the only practical means of assessment. Where they refer to reported behaviour their potential limitations must be acknowledged – particularly with respect to recall accuracy and where issues of social desirability may be present.

C) An objection may be raised that interviews with sixteen participants do not provide a sufficient basis for drawing firm conclusions. In response to this, it may be said that the data gathered were extensive, with later interviews pointing to data saturation being reached (Francis et al., 2010). In addition, the qualitative data provided evidence of a consistent pattern of psychologically dependent relations reported by participants across the board – relations which are increasingly being reported as of concern in other sectors of society, notably in primary and secondary education where effects of technology addiction and compulsive technology use on academic performance and motivation have been documented (Karadağ & Kılıç, 2019; Aziz et al., 2024; Kutluay & Karaca, 2025). It is the consistency of this overall picture which adds to the credibility and validity of the findings. Despite the potential limitations of small-scale qualitative investigations, the data gathered from them is extremely sensitive to context and can highlight meanings underpinning observed quantifiable relationships. Because it is not dependent on formal psychometric measurement, these meanings arguably provide the most useful data for policy driven decision making.

D) With hindsight and given that the psychological nature of respondents' relationships with technology was not so apparent at the study's outset, future work would benefit from the inclusion of a range of more precise, well validated measures of psychological functioning, for example with regard to mood, well-being and personality, as well as data on the surrounding social, interpersonal and institutional context within which participants pursue their studies and utilise technology. This would be likely to yield important information on the semantic and emotional field permeating students' interactions with technology. Such psychological and psychosocial data might also prove adept at identifying, in specific sub-groups of users, patterns of technology use which render individuals more or less vulnerable to harmful effects. To neglect these psychological and emotional dimensions to technology use would be tantamount to assuming that doctoral students' relationship with technology can be adequately formulated and understood within the bounds of students' own prescribed rationality as well as the rationality which lies behind the design of specific technologies. The data here suggest they cannot. However, it is important to acknowledge that the interviews were conducted subsequent to the major disruptions caused by the COVID-19 pandemic. This means that participants' narratives may have been affected by attempts to reframe the meaning of events after the fact. This does not challenge the findings; in fact it highlights the nature of the data as reflecting momentary constructions made by participants at the time of the interview, and subject to the contextual influences which were alive at that time.

10.4.3 Philosophical Limitations

The present study adopted a critical realist ontology and a social constructionist epistemology in a mixed methods-design. This allowed the study to acknowledge de facto structural pressures on doctoral researchers, including the pandemic, introduction of new technologies, and technological systems, institutional expectations, and supervisory practices. At the same time social constructionism drew attention to subjective meaning-making, interpretation and the emotional dimension to digital academic life. This permitted the work to explore a more nuanced view of technological engagement amongst doctoral students, but it does not make any claims about the universal validity of findings or of postulated causal processes, for example underpinning satisfaction with study progress. What the study does provide is a picture of plausible processes operating within specific contexts, which are affected by both material factors and interpretive processes. This gives the findings both contextual relevance and depth.

10.5 Future Research

In the course of discussing the findings from this study, several avenues of future research have been highlighted. These recommended areas of further research reflect the contextual nature of the doctoral experience during and after the COVID-19 pandemic. They are summarised below.

1. Longitudinal research will need to track changes in the social, emotional, cognitive, interpersonal and practical relations which doctoral students currently enjoy with technology. This design would permit researchers to explore whether the pandemic era shifts in technology use and engagement represent temporary responses or reflect an enduring cultural shift. This work will benefit from the inclusion of a range of precise, well validated measures of psychological functioning (personality, mood, mental health and well-being). In addition, such work would also make it possible to examine whether students' relationship with technology changes over the course of their studies and if this affects their relationship to their work.

2. How technology users frame their own understanding of the digital environment in which they study needs to continue, and how this might change in response to ongoing technological developments. This understanding needs to be explored in the context of wider social, cultural and technological influences. There is an evident need to examine how doctoral students continue to negotiate the ethical, epistemological, practical and pedagogical implications of AI assisted work (Williamson & Eynon, 2020).

3. How doctoral engagement, motivation and identity are shaped by the structural and technological landscape of higher education warrants continued exploration. To this end, comparative studies across universities and international settings may help to elucidate the extent to which the current findings are context or socio-culturally specific or reflect broader structural phenomena in contemporary doctoral education.

4. Ongoing evaluation of the balance between the gains and losses entailed by technology use in relation to psychological and social well-being, academic productivity and the social cohesion of the academic community.

5. How best to ensure provision and communication of support and assistance to students who have different academic and emotional needs.

6. The putative causal relationships suggested by the study will require further empirical confirmation.

7. In considering the relationship between doctoral students and their supervisors, it will be important to determine whether the patterns of technology use of academic staff and the meanings they employ differ from that of their students. In addition, how both supervisory practices and established communities of practice in academic settings respond to the challenges posed by AI warrants ongoing investigation.

8. The issue of the perceived control of technology and doctoral students' role in contributing to this warrants further investigation.

10.6 Recommendations

I began this project – what now seems a long time ago – with a desire to give back to the academic community, particularly to other doctoral researchers, something in the form of recommendations which this research might usefully lend itself to and which might contribute to postgraduate life running a little more smoothly and efficiently. I view this as part of the wider ethical responsibility intrinsic to conducting this work. Accordingly, I have set out below a series of suggestions. These are rooted both in the literature I have encountered and in the empirical findings from the current study.

Based on the present research findings, several conclusions and recommendations can be tentatively proposed. These are relevant to researchers, supervisors, institutions and policy makers and are made with a view to promote the beneficial use of technology by doctoral students, and to aid their well-being while doing so. The findings strongly suggest that institutional policy, where implemented, should not assume that technological proficiency can be aided solely through technical solutions. Attention to the relational, emotional and contextual dimensions of doctoral students' technological experience is of importance.

1. Gathering information from doctoral students prior to commencement of their studies will be beneficial. This could cover anticipated training needs, prior experience, and level of familiarity with specific areas of technology, attitudes towards technology, potential problems encountered, what technological aims they have for their programme of study and what tools they envisage using. This may be of specific benefit in identifying students who experience difficulties in using or learning software.

2. While many participants exhibited considerable digital autonomy, and were largely self-taught, there is a need for structural supports that complement students' existing strengths, and which cater for more technologically disadvantaged students. Training could be made available and accessible for both general and specific areas of technology use, for example, data analysis, videoconferencing and appropriate use of generative AI, as well as for discipline specific software/hardware. Such training might best be delivered in groups but could in any case be subject to periodic evaluation and revision to ensure its effectiveness. Training of supervisors in digital communication is an ancillary of this and other suggestions.

3. Provision of regular peer support groups, where both psychological and technical resources can be accessed. These forums can provide opportunities for concerns to be raised and discussed both individually and collectively. The groups can function as a means for sharing practical tips as well as providing motivational assistance and emotional support. The regularity of the meetings can be decided based on common consent and perceived need, with a suggested minimum of two per semester considered a realistic aim. As with training these could be subject to evaluation.

4. Digital well-being is essential for academic productivity (Al-Mansoori, Al-Thani & Ali, 2023). Forums/Workshops for training and support can be used to provide specific guidance and assistance with time management and address issues of prolonged online engagement, overuse, and addiction to technology. Explicit links to student health services for general well-being and psychological support should be made available, with options for presentations by health workers and student counsellors to be considered as well as presentations by individual students.

5. Specific ‘training’ space could be made available for both doctoral students and their supervisors to discuss issues around the use of artificial intelligence – to promote responsible use and to understand the risks that come with it.

6. Research is called for to evaluate the effects of the availability and use of artificial intelligence tools on the levels of social cohesion, trust and functioning of the general academic community, in both online cohorts and those pursuing traditional study programmes. Institutions could aim to develop clear frameworks for responsible AI use, grounded in academic integrity, transparency and respect for principles of intellectual property.

7. There is a need for ongoing research, utilising both quantitative and qualitative methods, to monitor postgraduate university life. This could assess mental health and well-being through appropriate standardised means, with these outputs considered in relation to academic progress and attainment, as well as for the identification of the psychological and emotional correlates of technology use and appraisal.

10.7 Final Reflections

In appraising the meanings and significance of the survey and interview data, the principle of reflexivity, as both an ethical and analytic practice, is important (Von Unger, 2021). Ethical reflexivity comprises not just ensuring the well-being of participants, minimising potential harms, respecting human rights and providing appropriate information, but also consideration of the wider social and educational implications of the research –for doctoral students in general and with regards to existing practices in higher education. This perspective aligns with the constructionist, epistemological principles upon which the research was founded. The higher education system can be viewed not simply as a single monolithic institution but as a transnational organisational form, dependent on the views and behaviour of multiple actors and stakeholders. It is a form that is both subject to change due to human agency and open to it.

As a doctoral researcher myself, I feel my own ‘positionality’ and experience contributed in no small way to the design of both the survey and interview schedule. While reflexive techniques, such as bracketing assumptions, triangulating survey and interview data, and keeping track of decisions made, were employed to ensure data integrity and minimise inappropriate influence, any notion of interpretive neutrality must be set aside. Reflexivity then, rather than being a problem, can gather strength from the personal experience and insights of the researcher, and these can inform the interpretation of qualitative data.

In writing this section I concur with Lumsden's (2019, p.2) view that in being reflexive, "social researchers cannot be separated from their autobiographies," and the values they subscribe to. In doing so, I was able to draw on what I had learnt from being both a doctoral researcher and user of technology. These aided me in deciding the types of questions asked, how they should be framed, how participants might usefully respond to them, as well as the appropriateness of both closed and open-ended questions to the research. Given the nature of ongoing technological innovation and growth, I intended for the survey to be as comprehensive as possible, within the time frame of the research. While developing this, I drew upon my own perceptions and appraisals of different technologies, reflecting on the difficulties as well as benefits I had encountered. Constructing the overall shape and format of the survey took a good deal of thought and involved several modifications before I was satisfied it was ready to go live. This process involved my own participation in several trial runs to identify potential flaws in both the logic and sequencing of questions and the means of completing the survey online. In this, I was influenced to a degree by my own training in the natural sciences, and sought to bring conceptual rigour to the survey, keeping in mind potential ways in which the data might be analysed.

As ChatGPT made its dramatic appearance during the later stages of the research, like many others I became aware of its impact on academic life. I was keen to explore some of the consequences of this in the interviews which followed the survey. In conducting the interviews, I was constantly aware that many issues raised by the interviewees were eerily familiar. This shared set of experiences I believe was useful in not only guiding respondents through the interview, but also in facilitating the openness, vulnerability, and willingness of the interviewees to tell me about their own experiences, for good or ill, and what sense they had managed to make of them. At times, the interviews felt as if they were an informal opportunity for experiences, successes and frustrations to be aired, shared and carefully explored. With the demands on my own time, I remained acutely aware of how respondents had kindly given up some of theirs to help me with the research. Thinking about the interviews as a shared, co-constructed endeavour, I believe, was a factor which enabled such wide-ranging and meaningful content to be elicited.

At a personal level, as someone with a background in natural sciences I have been repeatedly struck by the different research cultures of the natural and social sciences; though there are degrees of overlap, it has been an interesting journey to compare and contrast these and to think deeply about the nature of problems in the social sciences and how these are approached, theoretically and methodologically. This is a journey which I feel is likely to continue.

My final reflections on the research concern the overall significance of the findings. I believe that this work has conclusively shown that digital technologies are far from being neutral instruments. They are now tools which are firmly embedded in the intellectual, emotional, social, and cultural life of doctoral students, shaping how they see themselves, their colleagues, and their work. Their use has brought both real benefits and adverse consequences such as digital overload, poor time management and dependency. The overall impact of technology is one laced with ambiguity, aiding research, communication and analysis but also introducing new problems which affect time management and well-being and raise as yet unanswered questions about the ethical and environmental consequences of technology use. These outcomes represent real features of the doctoral experience rather than purely subjective constructions. Higher education institutions must now take note of this ambiguous nature of technology in how they support students and develop technology policies.

The data here raise important questions about the ongoing nature of doctoral study in the wake of the pandemic and the introduction of artificial intelligence. These speak to the practical challenges of helping doctoral students manage their technology use. At a time in which the processes of knowledge production are undergoing rapid change, they also allude to what, to me, is a more fundamental question, and that is one which concerns the kind of knowledge-building enterprise which the modern doctorate should aim to be, and with it the role and weight accorded to technology in the course of study. A critical tradition has viewed mastery of technology as more than just a necessary hurdle to surmount in order to enter the academy as a credited academic. This tradition also envisages doctoral education as a process of scholarly development, in which increasing one's skills aids one's growth both as a person and in the ability to engage in critical independent thought at a level thought necessary to make a worthy contribution to one's field of study (Lovitts, 2001; Castañeda & Selwyn, 2018). This process of identity development is dependent upon an appreciation of the importance of the human element in study – in peer dialogue, supervision and mentoring and the broader academic community of practice (Wenger, 1998; Li et al., 2009). As noted in the present work the technological ecosystem of today simultaneously enables and threatens this.

Based on the results of this study, it is evident that the model of doctoral education developing in this post-pandemic, AI-emergent period needs conscious attention to change rather than mere adaptation. The model that sees technology simply as an unbiased productive tool may reinforce the view that doctoral education functions as little more than a period of training with a predetermined output. Instead, the model based on the results of this study would see technology as a lens through which the researcher's involvement in ethics is understood as a process that defines who the researcher becomes, not just what they create. Thus, the recommendations proposed in this chapter are intended not only as practical solutions intended to meet identified institutional gaps but also as a call to create a new model of doctoral education that places human scholarly formation, community, and well-being at its centre.

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Appendices

1. Participation Information Sheet

2. Consent Form

3. Survey Questionnaire

4. Semi-structured Interview Schedule

Appendices

Appendix 1 Participant Information Sheet

Students' perceptions of the benefits and drawbacks of technology during their doctoral studies.

You are being invited to take part in a research study. This study will investigate the role of technology on doctoral students' perceptions of success in study. Before you decide to do so, it is important for you to understand why the research is being done and what it will involve. Please take 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 time to decide whether or not you wish to take part.

Thank you for reading this.

This research will focus on exploring the effects of use of technology on students' perceptions of their success in their research. There are certain factors which contribute towards student progress and persistence to complete their course. The investigation of the perceived effects of technology upon learning can help us to advise students on possible ways to improve the process of learning and producing research. We hope this will help to increase chances of success in completing their doctoral studies.

Please note that participation in this project is entirely voluntary. You may withdraw from this study at any time. This will have no adverse effects on any aspect of your course. Participation in this study will initially involve completion of this online survey with (later) options to participate in a focus group and interview.

The online survey will take around 30-35 minutes

All participant personal details will be kept confidential by the allocation of an anonymous ID number. Personal data will be destroyed at the end of the study.

Statement on confidentiality as required by the University Ethics Committee:

Confidentiality will be respected unless there are compelling and legitimate reasons for this to be breached. If this were the case, we would inform you of any decisions that might limit your confidentiality.

All research data from this project will be stored securely and used only for this study. It will be destroyed ten years after the completion of the study. The data will be used to write academic papers and to complete a Ph.D. thesis.
This project has been considered and approved by the University of Glasgow College Research Ethics Committee.

For further information, please contact:

Dr Naveed Akbar (m.akbar.1@research.gla.ac.uk)
or
Dr David Morrison-Love (david.morrison-love@glasgow.ac.uk).

In the events of any complaint please contact the College of Social Sciences Ethics Officer, Dr Muir Houston, email: Muir.Houston@glasgow.ac.uk

Appendix 2 Consent Form

Consent Form

- I confirm that I have read and understood the Participant Information Sheet (above) for the study and have had the opportunity to ask questions.
- I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.
- I acknowledge that participants will be referred to by pseudonym in any publications. In stored data participants will be referenced using anonymous IDs.
- I acknowledge that there will be no effect on my grades arising from my participation or non-participation in this research.

All Personal data will be treated as follows:

- All names and other material likely to identify individuals will be anonymised.
- The material will be treated as confidential and kept in secure storage at all times.
- The material will be destroyed once the project is complete.
- Confidentiality will be respected unless there are compelling and legitimate reasons where confidentiality may be impossible to guarantee. If this were the case, we would inform you of any decisions that might limit your confidentiality.

Appendix 3 Survey Questionnaire

First of all, there are some questions about yourself and your study.

2. Please state your age on your last birthday (in years):

   Please enter a number.

3. Please state your gender:

   Female

   Male

   Other

4. Please indicate your current nationality:

5. Please state your ethnic group:

6. In which Department are you currently studying?

7. In which University/Institution are you currently studying?

8. Are you studying Full time or Part Time?

   Full-Time

   Part-Time

9. How long have you been studying for your MPhil/Ph.D?

   Up to 1 year

   More than 1 year, up to 2 years

   More than 2 years, up to 3 years

   More than 3 years, up to 4 years

   More than 4 years, up to 5 years

   More than 5 years

10. Does the methodology you have employed/will employ for your research involve... Please tick all the boxes that apply.

Literature based

Qualitative methods

Quantitative methods

Mixed Methods (Both Qualitative and Quantitative)

General Software Use and Information Sources

The rest survey of the survey will consist of questions regarding the following areas:

General software use, search engines and sources of information, data capture and collection, data processing software, technology for data presentations, video-conferencing and communication and use of social media. The first series of questions will be about general software use and how you source information.

In the following questions you will be asked to indicate how much you agree or disagree with a number of statements. You will have five options, ranging from Strongly Agree to Strongly Disagree. These are Strongly Agree, Slightly Agree, Neither Agree nor Disagree, Slightly Disagree, Strongly Disagree.

Please tick the box that most closely matches your view.

11. I use technology regularly for my studies.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

12. I use online sources to access journal articles and books.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

13. Which electronic sources do you use for journal articles and books?

Please tick all the boxes that apply (If yours is not listed, please add).

Google Scholar

Scopus

University Library Database

Subject-specific online database accessible through the University

Any other number 1 (please specify)

Any other number 2 (please specify)

14. When reading, I prefer to have Physical Copies of the articles/books I access.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

The following questions are about how useful you find different electronic sources.

For each source listed below, please indicate how useful you find them; from not at all useful to extremely useful

15. Google Scholar

(1) Not at all useful

(2) Slightly useful

(3) Moderately useful

(4) Very useful

(5) Extremely useful

16. Scopus

(1) Not at all useful

(2) Slightly useful

(3) Moderately useful

(4) Very useful

(5) Extremely useful

17. University Library Database

(1) Not at all useful

(2) Slightly useful

(3) Moderately useful

(4) Very useful

(5) Extremely useful

18. Subject-specific online database accessible through the University

(1) Not at all useful

(2) Slightly useful

(3) Moderately useful

(4) Very useful

(5) Extremely useful

19. If you selected *Any other number 1* in question 13

Please specify below how useful you found it.

(1) Not at all useful

(2) Slightly useful

(3) Moderately useful

(4) Very useful

(5) Extremely useful

a. If you selected *Any other number 2* in question 13

Please specify below how useful you found it.

(1) Not at all useful

(2) Slightly useful

(3) Moderately useful

(4) Very useful

(5) Extremely useful

b. In Q.13 above, we asked you which electronic sources you use for journal articles and books. Are there any other electronic sources that you use for journal articles and books, that you have not mentioned so far? If there are please state below

Feelings on Electronic Usage Sources

The following items concern how you feel Overall about Using the electronic information sources above.

For each statement, please indicate your level of agreement from Strongly agree to Strongly disagree.

20. I feel Frustrated:

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

21. I feel Interested:

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

22. I feel Engaged:

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

23. I feel Bored:

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

24. I feel Anxious:

    (1) Strongly Agree

    (2) Agree

    (3) Neither agree nor disagree

    (4) Disagree

    (5) Strongly Disagree

25. I am Relaxed:

    (1) Strongly Agree

    (2) Agree

    (3) Neither agree nor disagree

    (4) Disagree

    (5) Strongly Disagree

Data Capture and Collection

In the following section you will be asked questions about your use of software for data capture and collection.

26. Do you use technology for data collection? A. For collecting information/data through a website (e.g., Survey Monkey).

    Yes

    No

27. Do you use technology for data collection? B. For collecting/recording information/data via video-conferencing software (e.g., Recording interviews or focus groups).

    Yes

    No

28. Please indicate which, if any, of the following benefits you find when collecting Information/Data through a website? Please tick all that apply.

    Saves time distributing questionnaires/surveys

    Enables easier recruitment of participants

    Helps in management of the data

    Data can be easily transferred to another package for analysis

    All of the above

    None of the above

29. Overall, I find the software I use for online data collection helpful.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

30. Please indicate which, if any, of the following benefits you find when collecting data through videoconferencing software. Please tick all that apply.

Saves time

Enables easier recruitment of participants

Helps in management of the data

Data can be easily transferred to another package for analysis

All of the above

None of the above

Data Processing

In the following section you will be asked questions about different types of data processing software

31. Which of the following software products do you use for word processing?

Please tick all the boxes that apply (If yours is not listed, please add).

Microsoft Word

Google Docs

Open Office

Any other please specify

a. If you selected Other, please specify:

32. I find the main software I use for word processing helpful.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

33. I am satisfied with the word processing software that I use:

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

34. Do you use any specialist software in your discipline?

Yes

No

a. If Yes – can you please list up to four of them.

35. Overall, I find the specialist software I use helpful.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

Quantitative Research Software

36. I use software for quantitative data analysis.

Yes

No

37. Which of the following do you use for quantitative analysis? (If yours is not listed, please add) Please tick all that apply.

Excel/Other spreadsheet

SPSS

SAS

Jamovi

EQS

Lisrel

R

Stata

Statistica

G Power

Any Other

38. Overall, I find the software I use for quantitative data analysis helpful.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

39. Please indicate how satisfied you are with the software you use for quantitative analysis.

(1) Very Dissatisfied

(2) Dissatisfied

(3) Neither Satisfied nor Dissatisfied

(4) Satisfied

(5) Very Satisfied

Qualitative Research Software

40. I use software for qualitative data analysis.

Yes

No

41. Which of the following do you use for qualitative analysis? (If yours is not listed, please add) Please tick all that apply.

NVIVO

Qualtrics

Other

42. Overall, I find the software I use for qualitative data analysis helpful.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

43. Please indicate how satisfied you are with the software you use for qualitative analysis.

(1) Very Dissatisfied

(2) Dissatisfied

(3) Neither Satisfied nor Dissatisfied

(4) Satisfied

(5) Very Satisfied

Presentation Software

In the following section you will be asked questions about your use of presentation software.

Yes

No

45. If so, which software do you use? (If yours is not listed, please add)

Please tick all that apply.

Google Slides

Powerpoint

Other

46. Overall, I find the software I use for presentations helpful.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

Video Conferencing and Communication

The following questions are about your use of video-conferencing and communication software.

47. I use videoconferencing software for data presentation.

Never

Rarely

Occasionally

Frequently

48. I use video conferencing software to communicate with fellow students/ classmates.

Never

Rarely

Occasionally

Frequently

49. I use video conferencing software to communicate with lecturers, tutors or supervisors.

Never

Rarely

Occasionally

Frequently

50. Which software do you use for video conferencing? (If yours is not listed, please add) Please tick all those that apply.

I don't use video conferencing software

Skype

Zoom

Teams

Googe Meet

Other

51. Overall, I find the software I use for video conferencing helpful.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

52. When using video conferencing software, the quality of the audio causes me discomfort.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

Technology & Software

53. Could you please indicate which of the following kinds of technology do you currently have?

Desktop Computer

Laptop Computer

Mobile phone

Tablet or IPad

This part of the survey uses a table of questions, view as separate questions instead?

a. For each of the following devices you use, could you please give a score between 1 and 5 for how satisfied you are with the performance of the device for your study. Where 1= Very Dissatisfied and 5 =Very Satisfied. If you do not have a specific device, you can leave performance of that specific device blank but please tick the performance of rest of devices.

Please don't select more than 1 answer(s) per row.

1 Very Dissatisfied 2 Dissatisfied 3 Neither Dissatisfied nor Satisfied 4 Satisfied 5 Very Satisfied

Workstation (University Desktop)

University Supplied Laptop

Desktop (for use at home)

Laptop Computer (personally owned)

Mobile Phone

Tablet or IPad

53. I use instant messaging to communicate with fellow students/ classmates.

Never

Rarely

Occasionally

Frequently

54. If so, which platforms do you use for instant messaging (If yours is not listed, please add) Please tick all those that apply.

Facebook/Messenger

WhatsApp

Teams

Google Meet

Other

55. Which of the above messaging platforms do you use most often?

    Please tick one box only.

    Facebook/Messenger

    WhatsApp

    Teams

    Google Meet

    Other

56. I prefer to use instant messaging to email when communicating with fellow students/ classmates.

    (1) Strongly Agree

    (2) Agree

    (3) Neither agree nor disagree

    (4) Disagree

    (5) Strongly Disagree

57. I prefer to use instant messaging to email when communicating with lecturers, tutors or supervisors.

    (1) Strongly Agree

    (2) Agree

    (3) Neither agree nor disagree

    (4) Disagree

    (5) Strongly Disagree

58. On a typical day when using instant messaging, I spend:

    Less than 30 minutes

    30 mins to an hour

    More than one hour and up to 90 mins

    More than 90mins and up to 2 hours

    More than 2 hours

59. On a typical day when using Email, I spend:

Less than 30 minutes

30 mins to an hour

More than one hour and up to 90 mins

More than 90mins and up to 2 hours

More than 2 hours

60. Overall, I find using instant messaging helpful in my studies.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

61. Overall, I find using email helpful in my studies.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

Recording Software

The following questions are about your use of software for recording

62. Do you record classes/supervision meetings as part of your study program?

Yes

No

a. If Yes Please indicate whether you record the sessions in Video or Audio.

Video

Audio

b. How often do you replay or relisten to each recording?

Never

Once

Twice

Three Times

More than Three Times

63. I find the technologies for recording lessons helpful.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

64. How do your lecturers/supervisors send you information? (e.g., lecture notes, research papers, feedback on work) Please tick all that apply.

Email

Microsoft Word/Word Processed

PDF

Powerpoint/Presentation software

WhatsApp/Messaging

Face to Face/In Person

Written (e.g. notes on original hard copy of document)

Video Conferencing

Telephone

Other

65. I find the technologies for receiving information helpful.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

Training

The following questions are about your experiences of training with technology

66. Have you ever received training in the use of technology?

Yes

No

67. For the following question please indicate which areas you have received training in. Please tick all that apply.

Literature searching

Data analysis software - quantitative

Data analysis software - qualitative

Spreadsheets (E.g. Excel)

Presentation software

Messaging software

Video conferencing

Subject Specific software

End Note/referencing software

Other

This part of the survey uses a table of questions.

68. For each of the following could you please give a score between 1 and 5 for how helpful you found the training.

Where 1= very helpful and 5 =not helpful at all. For any area in which you did not receive any training please leave blank.

Please don't select more than 1 answer(s) per row.

1 Very helpful 2 Helpful 3 Neither helpful nor unhelpful 4 Unhelpful 5 Very unhelpful

Literature searching

Data analysis software - quantitative

Data analysis software - qualitative

Spreadsheets (E.g., Excel)

Presentation software

Messaging software

Video conferencing

Subject Specific software

End Note/referencing software

Any other (if selected in the previous question)

Personal Use of Technology

The following questions are about your personal use of technology

69. Do you use any of the following software platforms? Please tick all that apply.

Twitter

You Tube

LinkedIn

Facebook

Snapchat

Instagram

File Sharing software (e.g., DropBox/Google Drive)

Image Processing Software (e.g., PhotoShop)

Other

70. If you were given the option to choose between studying online and undertaking a traditional campus-based programme (and assuming cost is not a factor), which would you prefer?

Online Program

Campus Based

71. Could you please briefly explain your reason for preferring an online programme or a campus based one?

72. I tend to spend more time on the internet than I had intended

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

73. Spending time online with study, affects how much exercise I take.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

74. Spending time online with study, affects my social life.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

75. Spending time online interferes with the quality of my sleep.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

76. Spending time online with study, affects my family life.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

77. I am happy with how I manage my time

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

78. For the following types of activity on the Internet we want you to rank them in order of how much time you spend on them in a typical day. Begin by selecting the activity you spend the most time on. This should be ranked first. Then select the activity you spend the most time on after this one. This should be ranked second, and so on. Please consider your study as work activity.

Please don't select more than 1 answer(s) per row.

Please don't select more than 1 answer(s) in any single column.

	First	*Second*	*Third*	*Fourth*	*Fifth*	*Sixth*
News						
Entertainment						
Work						
Social Media						
Shopping						
Surfing the Web						

79. How many hours in total do you spend ON A TYPICAL DAY using your Mobile Phone/Laptop/Desktop/Tablet..etc?

Please enter a whole number (integer).

80. My greatest satisfaction in using technology is....

81. My greatest problem in using technology is.....

82. I am concerned with the use of technology in respect of privacy/security issues

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

83. I find software applications are difficult to use/learn to use.

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

84. When using software/applications for work do you experience any of the following issues? Please tick all that apply

Slows computer down

Interferes with other applications/programs

Software hangs/becomes non responsive

Causes computer to crash

Drains battery power

data or program files are corrupted

85. Are there any software applications which are essential to your course, without which your study will be affected?

86. Which of the following means do you use to store/back up your data?

Cloud Storage

Google Drive

Drop Box

Computer Hard Drive

Portable Hard Drive

USB Drive/Flash Drive

University Network/Server Storage

External Media (e.g DVD/CVD)

Attached to Email

Any Other

87. How often do you back up data?

Several times a day

At least once a day

Several times a week

At least once a week

Several times a month

At least once a month

Less than once a month

Health and Well-Being

The next few questions are about your health and well-being

88. In general, would you say your health is:

Excellent

Very Good

Good

Fair

Poor

89. Compared to one year ago, how would you rate your health in general now?

Much better now than 1 year ago

Somewhat better than 1 year ago

About the same as 1 year ago

Somewhat worse now than 1 year ago

Much worse now than 1 year ago

90. The Covid-Pandemic has affected my studies

Very Positively

Positively

Not at all

Negatively

Very Negatively

91. If you felt the pandemic has affected your studies, could you very briefly indicate how

92. Stress refers to a situation where a person feels tense, restless, nervous, or anxious, or is unable to sleep at night because his/her mind is troubled all the time. Do you feel that kind of stress these days?

Not at all

Only a little

To some extent

Rather much

Very much

93. How much difficulty do you have in meeting the payment of bills?

None

Very Little

Slight

Some

Great

Final Questions

94. Overall, I am satisfied with the progress of my studies

(1) Strongly Agree

(2) Agree

(3) Neither agree nor disagree

(4) Disagree

(5) Strongly Disagree

95. Could you please say how you came to hear about this survey? Please select one answer only.

Email

Facebook

Twitter

LinkedIn

Snapchat

Information on another website

Told about it by friends or colleagues

Any other

Poster around campus

96. Would you like to be kept in touch about the results of the research?

Yes

No

97. If Yes, please leave an email address where you can be contacted...Only the researcher will have access to this.

98. As the aim of this research is to gain as much understanding of doctoral students' technology use as possible, I would like to conduct a focus group and individual interviews. These will not involve a big commitment of time. This is entirely optional. Please tick either or both of the boxes below if you would be willing to take part.

Focus Group

Interview

99. If you are willing to participate further, please leave an email address where you can be contacted...Only the researcher will have access to this.

Before submitting your questionnaire, you may use the previous button (to the left) to go back and answer any questions you have left out.

Appendix 4 Semi-Structured Interview Schedule

Structure of Interview
Introduction: General Usefulness (Positive and Negative) of Technology.
Training
Videoconferencing
Communication
Data Analysis
Time Management/Health and Well-Being
Study Progress
Prompts for interview in Red
Main questions in Bold
Optional questions

Introduction

1. How important is technology in your field of study?

2. How has technology enhanced your learning experience in your postgraduate program?

What positive experiences have you had?

What do you like the most about the use of technology in your studies?

Why is this? Please explain more....

3. **Can you think of any negative experiences that you have had with your studies when using technology?**

   For example, has technology ever hindered your work productivity in any way?

   If so....in what way(s)?

   Do you still use this technology?

   If Yes - Why is that? (lack of suitable alternatives / habit)

   Any other negative experiences?

4. Has the use of technology caused you to be distracted or interrupted you in your study? What do you do in response to this?

5. **Have you made use of any AI tools – for example ChatGPT? AI image generation**

   Can you tell me for what purpose/s did you use this for... (why?)

   ... and what were your overall impressions of it?

   Have you used it just the once or on multiple occasions?

   Did you encounter any problems?

   Do you always find its output trustworthy? (Why/Why not?)

6. **Question for part time students only.**

   As a part-time student has technology been of particular use for you? If so in what way?

7. **Would you like to be consulted about the technological resources available to students like yourself? If so ...Please elaborate**

8. **Does the ease of use of a piece of software affect how you use it and how helpful you find it?**

Training

1. **Have you received any training in the use of technology for your studies?**

   Are you self-taught? In what areas specifically?

2. **What were your impressions of the training?**

   Would you recommend this training to others? If yes – why – If no – why not?

3. **What training would you like to have that you haven't? (e.g., data back-up/videoconferencing)**

Videoconferencing

1. **Is Videoconferencing useful for your work? …Can you tell me in what ways?**

   What platform do you use and why?

2. **Do you use Videoconferncing more with lecturers or other students?**

3. Are there any problems with VC software? If so, what are these?

   Do you ever record lessons or tutorials?

   Do you see Videoconferencing playing any role in enhancing your own personal safety or contributing positively to your family life.

Communication

1. **How important is communication technology for you as a doctoral student?**

   Has the importance of this changed since you started your study?

2. **Do you prefer face to face or technology-mediated interaction…please explain?**

   Do you think online study offers greater flexibility? What is your view on this?

3. **How has the pandemic affected your study and what role has technology played during it?**

Data

1. **Which tools do you for data analysis?**

   Do you have any problems in using them?

   Are you confident in using these? (ask about any previous training and experience in relation to software) -

2. **Do you have any concerns about privacy and security in relation to your study?**

Time Management/Health & Well-Being

1. **Do you have any difficulties managing your time effectively?**

   If so- what are these? Are these related to the use of technology?

   What are your strategies for managing your time?

2. **Does the availability and use of technological resources at work affect the way you use your time (e.g., sleep, social life, exercise/family life etc...)**

3. **Do you think you spend too much time using technology (smart phone, computers etc)?**

4. Is your well-being affected by using technology? If so, how?

   Have you received any advice/help from the institution?

   Are you satisfied with the support available to you? Please explain.....

5. **Is the way you manage time at work/study different to how you manage it at home?**

6. **Do you think time management should be a part of your training as a doctoral/postgraduate student?**

Study Progress

1. **Are you happy with the progress you are making in your study?**
2. **What role if any does technology play in contributing to or hindering your progress?**

   Prompt: e.g., distraction, wasting time, information overload
3. **Are you happy with the research tools available for you at your institution?**

   Would you like to have more resources?

   Do you have access to all the tools/equipment you need?
4. **Do you think social media or messaging platforms hinder your work productivity in any way?**

Final Question

Is there anything else you would like to add about your use of technology in relation to your studies?