Non-STEM researchers' use of technology for research activities: A phenomenographic analysis identifying varied experiences, the relationships between them and the structure of awareness

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Abstract

The government and funding bodies encourage researchers to develop their use of technology and related e-Infrastructure to enhance research. Due to the disciplinary nature of research, this study focuses on researchers from non-STEM areas, such as Arts, Humanities, Social Sciences, Business and Law, and aims to understand their experiences of using technology. The study used a phenomenographic approach to map and understand the experiences of 26 experienced researchers from 10 Further and Higher Education institutions in England. Marton and Booth's extension of subject-object relationship (Piaget, Brentano) and the structure of awareness (Gestalt, Gurwitsch) were used to theorise the data. The findings describe researchers' experiences of technology use by categorising them in four prominent ways: Irrelevant (in the background of research); Secondary (led by research); Integral (embedded in research); and Informing (complementing research).

The thesis maps the outcome space of this phenomenographic analysis and shows that variation in the experiences of using technology amongst these researchers can be understood in terms of their structure of awareness, that is, which critical aspects are in their focus at that particular point. These critical aspects are informed by the way researchers have experienced research, and their experiences of technical support and development. The variations are also related to the subject-object relationship between the researcher and the direct object (technology) as well as between the researcher and the indirect object (aims or benefits). Furthermore, a particular researcher could experience technology use differently depending on these combinations of focus in different situations, and they could move from one way of experiencing to another by being aware of the different ways of experiencing through their peers or professional development programmes.

The thesis offers insights into the range of ways in which researchers approach research tasks through the lens of technology use. It makes an original contribution through this description and analysis of the qualitatively varied ways in which researchers experience technology use in their research and the critical aspects that explain these variations. In addition, it makes a methodological contribution in relation to the use of a phenomenographic approach for understanding the issues and questions in the area of researchers' use of technology.

Contents

Word count: 54,816

List of figures and tables

List of figures

List of tables

List of abbreviations

AHSSBL	Arts, Humanities, Social Sciences, Business and Law
CPD	Continuous Professional Development
ECR	Early Career Researcher
EU	European Union
HEFCE	Higher Education Funding Council for England
HEI	Higher Education Institution
ICT	Information and Communication Technology
IDR	Interdisciplinary Research
Jisc	Joint Information System Committee
OfS	Office for Students
PDR	Post-doctoral Researcher
PgA	Phenomenographic Analysis
PGR	Postgraduate Researchers
REF	Research Excellence Framework
SSH	Social Sciences and Humanities
STEM	Science, Technology, Engineering, and Mathematics (and Medicine)
TpA	Template Analysis
UKRI	United Kingdom Research and Innovation
VLE	Virtual Learning Environment

Glossary of terms

STEM	Disciplines of Science, Technology, Engineering, and Mathematics and sometimes clinical subjects such as Medicine.
Non-STEM	Disciplines such as Arts, Humanities, Social Sciences, Business and Law.
Research	An evidence-based practice about creating new knowledge in areas of specific interest.
Scholarship	About being intellectually interested and seeking knowledge; broader activity than conducting research.
Intellectual activities	Refers to research activities such as discovery of knowledge, new understanding, and interpretation. Also includes critically evaluating, appraising, and making decision in relation to a research project.
Process-based activities	Refers to systematic or methodical approaches to research activities such as organising or structuring of data and facts. Also refers to the experience of doing tasks and activities that are involved in realising research.
Technology	Broadly defined as tools and resources that enable and support research activities.
Technology use	Conceptualised as the knowledge, discernment and application of technologies and resources

Chapter 1: Introduction

Context: Research race for funding

In many countries, there has been an increasing focus on assessment of research quality in order to allocate government funding - for example, Excellence in Research for Australia, the Performance Based Research Fund Quality Evaluation in New Zealand, and the Research Assessment Exercise in Hong Kong (Browning, Thompson, & Dawson, 2013, p. 15). In the UK, the introduction of the Research Assessment Exercise in 2008 and then the Research Excellence Framework 2014 (and now 2021), have brought increasing emphasis on the research-teaching nexus in Higher Education Institutions (HEIs).

Research funding is allocated based on the quality, volume and relative cost of research in different subject areas, with separate calculations to reflect research outputs, environment and impact (HEFCE, 2017, p. 6). For subject fields where the relative costs of research are higher, they attract a higher rate of funding: for example, laboratory-based research is more expensive and thus allocated more funding than library-based research (2017, p. 14). That is, STEM disciplines which include Science, Technology, Engineering and Mathematics (and clinical subjects such as medicine; see HEFCE, 2017, p. 41) are likely to secure higher funding. In addition, funding will be allocated only if the research quality is internationally excellent or world leading, that is, 3 stars or 4 stars (2017, p. 29). This means researchers in non-STEM disciplines such as Arts, Humanities, Social Sciences, Business and Law (AHSSBL) are under additional pressure to produce high quality research more efficiently if they are to keep abreast of the competition. That is, non-STEM researchers have to be efficient and effective in all phases of research from securing funding and conducting the research, to communicating, collaborating and disseminating the outputs.

Focus: Researchers and use of technology

Technology is ubiquitous and its use is evident in all parts of life (Lupton, 2014). There are no ‘Net Generation’ or ‘Digital Natives’ (Jones & Shao, 2011, p. 40) but rather we are all ‘Google generation’ (Rowlands et al., 2008, p. 301). Collaborative initiatives like the Basic

Digital Skills Framework (The Tech Partnership, 2017) ensure that people can achieve a minimum standard in managing information, communicating, transacting and problem solving. The government believes technology and innovation can help solve some of the most pressing problems facing the world and wishes to invest strategically in new infrastructure to open up new vistas for research, especially as digital technologies are changing the way research works in many disciplines (Gyimah, 2018, section: To shape the future, we need a plan).

In terms of research, there has already been considerable investment and encouragement from government and funding bodies around the use of technology (Department for Business Innovation and Skills, 2014, p. 31). Horizon 2020, the biggest EU Research and Innovation programme, expects to make every European researcher digitally proficient and increase creativity and efficiency of research through the provision of e-infrastructures (European Commission, 2015, para. 1). More specifically, the Researcher Development Framework (Vitae, 2011) also highlights the importance of technology use and skills for various research purposes. While being aware of the challenges, the framework calls upon researchers to willingly learn and develop additional skills and capabilities in information technology and digital technology, as appropriate.

Researchers have been studying the use of technology with an interest in a wide range of contexts including learning and teaching (Kirkwood & Price, 2014) as well as research (Sim & Stein, 2016). Studies about researchers' own conceptions and practices as well as their use of technology, however, are very limited (Evans, 2012, p. 425; Rees, Baron, Boyask, & Taylor, 2007, p. 776). The literature review (see Chapter 2) suggests that, among researchers, technology and its usage are referred to in a range of different ways. There are no clear definitions or specifications of its use rather than broader encouragements to use technology in their research. Despite the tensions between existing and new practices it is recognised that e-resources, multimedia, social tools and networks are transforming scholarship to a digital one (Weller, 2011). Studies recommend that HEIs and sector bodies should explore the potential that new technologies offer to create more effective communication and interaction between researchers and their peers, supervisors and the wider university support services (Hooley, Kulej, Edwards, & Mahoney, 2009, p. 3). There

are some debates around whether digital resources enhance rather than replace traditional practices of scholarship (Clegg, 2011, p. 183). Nevertheless, expectations are clear that an informed researcher understands how digital technologies contribute to research methodologies (Bent, Gannon-Leary, Goldstein, & Videler, 2012, p. 6). The next section explains my personal orientation in relation to studying researchers and their use of technology.

Personal orientation to the study

My academic background and professional role in learning technology innovation at an HEI is STEM related. However, I worked closely and extensively with academic colleagues in a School of Education with non-STEM disciplines. In addition to teaching, my colleagues there also had an increasing responsibility for securing funding and conducting research in their relevant fields. I had noticed their varied usage of technologies for teaching and learning activities and wondered how they used technology for research. There has already been an increased focus and support for the use of technology in learning and teaching. Hence, I reasoned, researching was an area that required more study especially in connection with researchers' experiences of using technology and its effects in constructing knowledge.

In my various professional roles of advising and working with colleagues across higher and further education sectors, I have been exposed to a range of responses from colleagues as they adopted technology in their teaching, learning and research. I have heard occasional apprehensive assertions or confident rejections about the role of technology in academia. Weller picks up on this behaviour and defends:

> ‘Technology isn't important’, ‘pedagogy comes first’, ‘we should be talking about learning, not the technology’ are all common refrains in conferences and workshops. While there is undoubtedly some truth in these, the suggestion that technology isn't playing a significant role in how people are communicating, working, constructing knowledge and socialising is to ignore a major influencing factor in a complex equation (Weller, 2011, p. 11)

As in Weller’s observation, some of my colleagues dismissed or diminished the role of technology use in different educational activities, while others were enthusiastic about

using it. I often wondered what had informed their experiences as it was unclear to me whether their reactions were part of their informed judgement or they were ignoring the unknown. In addition, to my surprise, those who dismissed technology in one context, were using it in another context. It was interesting to observe the difference in use of technology by the same individual in different contexts and also the differences among various colleagues. Such experiences have also stimulated my line of enquiry in this thesis.

Experienced researchers often have conventional ways of conducting their research. However, technological developments and the new avenues and forms of data that they generate require new ways of working with the technology. Understandably this might be experienced as a technological burden or even a distraction. This study has taught me that apprehensive assertions about use of technology are not necessarily pejorative but could be related to various aspects of technology or its usage that people focus upon at a given point in time. The next section discusses the context and focus of this study and presents the warrant for it.

Warrant: Understanding researchers' varied use of technology

My initial literature review suggested that researchers were an understudied population, especially with respect to the use of technology. Existing studies were mostly about post-graduate researchers (PGRs) (Carpenter, Wetheridge, & Tanner, 2012; Slight, 2017; Stubb, Pyhältö, & Lonka, 2014), post-doctoral researchers (PDRs) (Åkerlind, 2005c; Pitcher & Åkerlind, 2009), and early career researchers (ECRs) (Ashwin, Deem, & McAlpine, 2015; Tynan & Garbett, 2007). Since there were limited studies about experienced researchers, I decided to focus on that population. Although various studies focused on researchers' experiences (see the literature review in Chapter 2), there were none about how experienced researchers from non-STEM disciplines use technology for research where it is not as integral a part of their research process as it might be for some STEM disciplines.

Some literature has recognised the need for understanding the use of technology in relation to research. Kirkup (2010) suggests academia would do well to encourage some of its best scholars to embrace the traditional approach equally with new technological

developments to provide models for multiphrenic academic identities. As Dutton and Meyer (2010, p. 180) assert, it is important that trends in research practices and engagement with technology use are tracked over time to study the implications for researchers that could unfold in the coming years.

My professional experience also led me to identify this as an area that needs to be understood further, as although the value of technology use is recognised generally, its use appeared to be limited as well as varied. A pilot study among my research colleagues suggested that technology had a range of forms from pen and paper to relatively new developments such as social media tools and smart phones, while for others it meant research specific tools such as EndNote, SPSS, ATLAS.ti and NVivo. The use of technology also varied across the different stages of research from bidding for funding to dissemination of findings.

I believe these varied and wide-ranging experiences of the use of technology among researchers warrant further study. Technology is ubiquitous and is valued by government, funding bodies, and various studies. Use of technology is an important factor in social and educational research; however, the time and money invested in technologies and tools, and its development and training programmes need to be studied and reviewed.

This area of study is very broad and has a diverse range of factors and variations. From a broader perspective, there are questions about the basis on which the governmental bodies and funders could invest in research infrastructure and technology related initiatives. From the researchers' perspective, there are questions about the types of technologies they use and how they use it; whether researchers know about other ways of using and experiencing technology; what makes these ways of technology use different and/or whether they are related; whether researchers focus on particular technologies or the affordances and benefits of the same; and, probably, should researchers even think about their use of technology or just focus on their research? Encapsulating some of these questions, the next section outlines the research aims, questions and approach.

Research aims, questions and approach

The aim of my study was to understand a broader picture of the field than one institution, to more fully investigate the different ways researchers use technology. The overall aim was to understand the range of different experiences of using technology and its relevance to researcher development among experienced non-STEM researchers. The research questions were:

- RQ1. What are non-STEM researchers' experiences of doing research?
- RQ2. What types of technologies do researchers use and how?
- RQ3. In what ways do researchers experience or conceptualise technology use?

My study builds on the works of Angela Brew (2001, p. 280) and Gerlese Åkerlind (2008a, p. 25) which focus on the ways of experiencing research, and aims to develop a new mapping that provides additional insights into how researchers experience research especially in light of the increasing pressure on them.

A phenomenographic approach is used to map the varied experiences and identify its critical aspects. The analytical framework combines phenomenography and template analysis, and focuses on accounts of researchers' ways of experiencing the use of technology. The study examines the relationship between researchers' experiences of conducting research and their use of technology for research. It identifies the limited number of qualitative variations in experiencing technology use in research and the structure of those variations. Marton and Booth's (1997) extension of subject-object relationship inspired by the works of Piaget, and Brentano (Marton, 1981; Morrison, 1970), the structure of awareness that stems from Gestalt psychology (Linder & Marshall, 2003, p. 273) and Gurwitsch's structure of awareness (Gurwitsch, 1964, pp. 341–344) are used to theorise the data. The discussion of the findings illuminates how researchers approach the use of technology and to what extent they use established and proven technologies or take risks and follow innovations.

Definitions and delimitations

For this study, 'technology' was broadly defined as tools and resources that enabled and supported research activity. In this thesis, the focus is on use of technology rather than on technology itself, as researchers could be using technology in various contexts and it would not be feasible to understand the variations within the remit of their research activities. In line with a phenomenographic approach (Marton & Booth, 1997, p. 136), the study focuses on researchers' experiences of using technology as a group not as separate individuals. This is explained further in Chapter 3 pages 51-53.

Contribution to knowledge and its significance

This thesis makes an original contribution to knowledge in a number of ways. The application of phenomenography to study the topic of experienced non-STEM researchers' use of technology is unique. In doing so, the thesis builds on the available literature about researchers' experiences and reveals the complex research-technology nexus in non-STEM disciplines.

My contributions include the description and analysis of the qualitatively varied ways in which researchers experience technology use in their research and the critical aspects that explain these variations. Highlighting the types of technologies used and ways of using them, this thesis argues that rather than the conceptions of technology, it is the conceptions of research that critically informs experienced non-STEM researchers' use of technology. The study also illustrates how researcher development could contribute to moving researchers between categories of experience through the change in focus on subject-object relationship and the awareness structure. This thesis also offers insights into the range of ways in which researchers approach research tasks through the lens of technology use.

My contributions would be significantly useful in understanding the decisions researchers make to use or not use technology for their research projects. This knowledge will also help to develop and enable researchers to study the social and economic areas of digital developments. In summary, the thesis advances tangible ways in which experienced

researchers, research supervisors, technology advisors and funding organisations can better support non-STEM researchers in their use of technology.

Structure of the thesis

This chapter (Chapter 1) has provided an introduction to the thesis. It discusses the context and focus of this study and presents the warrant for it. Chapter 2 reviews the literature and maps the studies about researchers and their use of technology. Chapter 3 outlines the phenomenographic research approach and covers the conceptual, theoretical and analytical frameworks. It also includes the data generation and management approaches, and discusses the trustworthiness in terms of validity and reliability. Chapter 4 addresses the first research question. Based on existing models it analyses and presents non-STEM researchers' varied experiences of conducting research. Chapter 5 addresses the second research question. It provides a snapshot of researchers' front line experiences of using technology and highlights the range of tools and the different ways in which they use them. The chapter also argues that professional development is key to researchers' effective use of technology. Chapter 6 addresses the third and final research question. Using phenomenographic analysis it identifies four prominent categories of description in terms of researchers' experience of using technology in non-STEM research. It also presents an outcome space illustrating the relationship between categories with discussion of its design. Finally, Chapter 7 draws together the findings from Chapters 4, 5 and 6 and provides a discussion of the findings before outlining the conclusions.

Chapter 2: Studies about researchers and their use of technology

Introduction

This chapter locates my study among the literature on researchers' roles and activities and how they use technology for research. It reviews the literature in the wider context of researchers and researching before focusing on the researchers' use of technology. As illustrated later, experienced researchers are an understudied population, and the foci of existing studies do not cover many aspects related to researchers' experiences. This chapter identifies the literature relevant to researchers' roles and activities to provide the diverse and challenging nature of their work. Many studies seem to have used survey (Barjak et al., 2010; Carpenter, 2012; Davé et al., 2016; Kyvik, 2012; Mellors-Bourne & Metcalfe, 2013; Slight, 2017) and interview approaches (Ashwin et al., 2015; Chubb & Watermeyer, 2017; Collins & Jubb, 2012; Evans, 2015; Hawtin, Davies, & Hammond, 2010; Pitcher & Åkerlind, 2009; Stubb et al., 2014) to study researchers' experiences. The number of participants involved varied hugely – from 10 to 50 in the interviews and in 1000s when it came to surveys. Some of the studies that had large numbers of participants were PGRs, including doctoral students, who do not represent the population of my study. However, the issues and insights they raised have been drawn on to illuminate some of the common issues that are relevant to my study, including the use of technology, as elucidated in the following sections.

This chapter focuses on the common issues and varied experiences of researchers that were raised in the literature and discusses the key ideas and range of terms used to refer to technology use. It then summaries the key arguments from the literature review and highlights the varied experiences of researchers and their use of technology.

Disciplinary differences in research

Since my study focuses on non-STEM researchers and their use of technology, the first task has been to differentiate it from STEM research. Although some studies argue that discipline is not a significant factor in how academics view research (Brew, 2008, p. 426),

there are others that highlight and address discipline-specific issues, showing that there are disciplinary differences. Often, the discussions start in the form of how some disciplines (for example, Humanities, Arts and Social Sciences) are being undervalued in the field of research (Benneworth & Jongbloed, 2010, p. 576; Shaw, 2015, section - The key issues). While some of these disciplinary differences could be geographical (Tight, 2013, p. 136), methodological differences and the type of knowledge values could also make disciplines distinct, especially in shaping the relationships between teaching and research across different disciplines (Lucas, Healey, Jenkins, & Short, 2008, p. 9). Over the last decade, the desire to address complex societal problems, achieve impact, and create value from working across disciplines has led to an increased emphasis on interdisciplinary research (IDR) among researchers, funders, and strategic leaders at HEIs (Davé et al., 2016, p. 7). Although there are many facilitating factors – such as interdisciplinary training, effective leadership, and institutional support – issues such as collaboration, discipline-oriented cultures, career-related barriers, evaluation of research outcomes, and limited funding, compared to monodisciplinary research, have acted as barriers for IDR (2016, pp. 8–10). These disciplinary and interdisciplinary issues highlighted above confirm that there are clear and significant differences among disciplines in the field of research. Hence, it can be said that studies about researchers fall into two groups: across disciplines, and discipline specific (Pham, Bruce, & Stoodley, 2005, p. 216). My study is a mixed kind, where it includes multiple sub-disciplines; however, it also tends towards the second group because it focuses only on non-STEM disciplines.

Varied experiences of researchers

Conducting research on researchers is a neglected (Brew, 2001, p. 272) or inadequately researched (Kiley & Mullins, 2005, p. 246) and relatively new field of study, having developed only over the past few decades (Browning et al., 2013, p. 15). The relevant literature on researchers and researching focuses predominantly on PGRs, especially doctoral students, their curriculum, researching, and lived experiences (Bruce, 1994; Bruce, Stoodley, & Pham, 2009; Capraro & Thompson, 2008; Carpenter et al., 2012; Marton & Svensson, 1979; Stelma, 2011). Nevertheless, a growing body of literature extends its interest beyond doctoral issues and focuses on experiences and activities of

researchers right from post-doctoral researchers and early career researchers to leading experts in their fields of research (Åkerlind, 2005c, 2008a, 2008b; Bent, Gannon-Leary, & Webb, 2007; Brew, 2001; Evans, 2012; Pitcher & Åkerlind, 2009; Tynan & Garbett, 2007). However, Evans (2012, p. 425) acknowledges that we still do not know enough about researchers, particularly academics as researchers. Further, Rees et al. (2007, p. 776) emphasise the need to understand the conditions of work and wider social relations of educational researchers to help build their research-capacity.

Defining research and researcher

In terms of what is research and what it involves, Bent et al. provide a definition:

> research activity primarily involves the discovery of knowledge not previously known or understood or the development of a new way of organising or structuring known material that provides a new understanding about its subject matter. Scholarly research therefore is systematic or methodical, involves the discovery and interpretation of facts or the revision of accepted theories in the light of new facts. It may also involve the practical application of new or revised theories (Bent et al., 2007, p. 83).

In terms of a definition of research, Bent et al. encapsulate both intellectual (discovery of knowledge, new understanding, and interpretation) and process-based activities (systematic or methodical, organising or structuring). This is a useful starting point from which we could begin to explore deeper into the varied aspects of research and researchers' experiences, perceptions, actions, and their research journey. In terms of defining the term 'Researcher', the literature refers both to academics for whom research is, or is intended to be, a component of their work and of their contractual responsibilities, and to those employed in research-only roles (Evans, 2009, p. 134).

Varied views of research and scholarship

The literature helps to clarify the distinction between research and scholarship. Boyer's (1990, p. 25) study refers to four scholarly categories, which are inseparable but divide intellectual functions into the scholarship of discovery, of integration, of application, and of teaching, whereas Veletsianos (2013, p. 649) uses scholarship referring to research, teaching and service activities. It can be argued that research is not the same as

scholarship but a part of scholarship, which has a finite state similar to a project with set limits and expected outcome. Scholarship is differentiated as a more wider activity, which is about being intellectually interested and scholars being seekers of knowledge, whereas research is an evidence-based practice around areas of specific interest, and researchers are creators of knowledge (Central Queensland University, 2010). Many studies reviewed here do not make such specific distinctions about the attributes of their research populations. However, my participants were more researchers than scholars, as they had specific research interests with time-bound outcomes and were linked to specific research age (see Appendix 1a–c).

Research ages, activities and roles

The experience of being a researcher can be varied, depending on many factors; some of the key ones include research (not researcher's) ages, roles and activities. Bent et al. (2007, p. 85) identify 'Seven Ages of Research' as: 1. Master's students; 2. Doctoral students; 3. Contract research staff (CRS); 4. Early career researchers; 5. Established academic staff; 6. Senior researchers; and 7. Experts. This linear model shows the progression of a researcher's journey. There are plenty of studies about researchers in ages 1 and 2 (Master's and Doctoral students) (Carpenter et al., 2012; RIN, 2008; Rowlands et al., 2008; Slight, 2017; Stubb et al., 2014). My study, however, focuses on researchers from research age 3 and above. There are also studies about post-doctoral researchers, CRS researchers, and early career researchers, covering research ages 3 and 4 (Åkerlind, 2005c; Ashwin et al., 2015; Pitcher & Åkerlind, 2009; Tynan & Garbett, 2007), as well as the rest of the ages from 5 to 7 (Bills, 2004; Brew, 2001, 2008; Colley, 2014; Evans, 2012; Langfeldt & Kyvik, 2010; Matier, Clinton Sidle, & Hurst, 1995; Mellors-Bourne & Metcalfe, 2013; Simons & Elen, 2007).

Academic researchers' varied activities include managing, conducting, publishing and evaluating research as well as networking and collaborating with others (Kyvik, 2012, p. 526). Kyvik illustrates the range of activities and the people they have to work with. Researchers must relate to research funding agencies, public authorities, academic colleagues, the university administration, research students, the lay public, and so forth,

and work with everyone's preferences and expectations about researchers' roles and behaviour (Kyvik, 2012, p. 536). Researchers' simultaneous roles include scholar, teacher, administrator, and many more. In addition, they also undertake various evaluator roles, which may conflict with the researcher role and with societal expectations (for example, political dynamics of peer review), which add to the tensions between these roles (Langfeldt & Kyvik, 2010, p. 199).

Research-teaching nexus

Research-teaching nexus is an area with increasing number of studies and presents varied experiences and arguments (Åkerlind, 2004; Brew, 2006; Macfarlane & Hughes, 2009; Malcolm, 2014; Prosser, Martin, Trigwell, Ramsden, & Middleton, 2008; Shreeve, 2010; Simons & Elen, 2007; Tight, 2016a, 2016b; Trigwell & Prosser, 2009). Research and teaching are sometimes seen as distinct activities that can be related in order to help meet the aim of higher education (Simons & Elen, 2007, p. 623). It could be argued that research is seen as harder and more demanding compared to teaching. In the context of a career promotion, it is not that difficult to accurately represent teaching activities (for example, list of courses and committees) compared to convincing a promotion committee made up of mixed level of subject experts, who will require explanation and clarification on the nature of a researcher's contribution to the field (Weller, 2012, p. 350).

Some researchers experience the teaching-learning process as of no benefit to themselves and drawing on their time for research, while others may experience it as extending their own understanding of familiar content areas, thus enhancing or benefiting their research (Åkerlind, 2004, p. 374). The latter experience would link with an idealistic point of view in that, a good researcher is also a good teacher, as far as their research has an educational potential (Simons & Elen, 2007, p. 628). Some studies encourage a close link between research and teaching, as it could help the students understand how the object of study is situated in the wider field than experiencing teaching as a sharing of isolated packets of knowledge, while the teachers would experience their own research as a series of unrelated projects (Prosser et al., 2008; Trigwell & Prosser, 2009). There is some focus on how the research-teaching nexus can enhance the quality and outcomes of the learning

experience for both students and academics (Malcolm, 2014, p. 289). Having said that, it is not the research quantity but continuous maintenance and development of scholarship in their own field, which is more important (Prosser et al., 2008, p. 13). The idea of the research-teaching nexus has gained importance in the last three decades and more studies need to be conducted to explore in detail what actually happens in practice (Tight, 2016a, p. 293).

Pressure to secure research funding

Bidding for funding and securing it are among the key expectations on experienced researchers. Funding comes from the UK and International Governments, independent Research Councils and related bodies. The HEFCE (now replaced by UKRI and OfS) has allocated £1.6 billion for research (HEFCE, 2017, p. 12). The Jisc, formerly known as the Joint Information Systems Committee, funds development and champions the use of digital technologies for education and research in UK (HEFCE, 2017, p. 39).

There are huge challenges and competition in securing funding, as evident from the literature. In terms of funding for electronic infrastructure, the 'E-infrastructure Leadership Council' (ELC) was formed in 2012 and had committed £5.9 billion investment into the UK's research infrastructure between 2016 and 2021 (Department for Business Innovation and Skills, 2014, p. 31). However, the ELC has been disbanded since November 2017. Another report suggests that recent changes in the research council standard grants scheme "could leave those social science researchers looking for smaller grants – between £10k and £350k – with nowhere to go" (Shaw, 2015, section - The key issues). In addition, Brexit (Britain's vote to leave the European Union) has created huge uncertainty for the entire research community, including social scientists, with a loss of £1bn a year research funding, leaving the access to networks and infrastructure at stake (Lenihan & Witherspoon, 2016, para. 1). Such uncertainty and competition have put huge pressure on researchers, especially in the last ten years. Bent et al. (2007, p. 82) note that there is an increased pressure of performance measurement in order to justify what is being done to support researchers especially at a time when budgets are declining. The effects of such pressures are now evidenced in studies. For example, Chubb and Watermeyer (2017, p.

2364) have found strong evidence that in order to acquire research funding, the applicants (researchers) may exaggerate the impact claims of prospective research, especially where it is not immediately obvious. Such instances illustrate the challenging and competitive nature of being a researcher beyond the traditional scholarly activities.

Conceptions of research and being a researcher

These issues (of teaching and funding pressures) lead to studies of varied conceptions and experiences of doing research and being a researcher. Marton and Svensson (1979, p. 484), from their study on the conceptions of research into student learning (see Figure 1), have identified differences in the conception of the research process into six aspects.

Perspective	EXPERIENTIAL	– OBSERVATIONAL
Description	QUALITATIVE	– QUANTITATIVE
Conceptualization	CONTEXTUAL	– GENERALIZED
Relations	INTERNAL	– EXTERNAL
Comprehension	UNDERSTANDING	– EXPLANATION
Use	EMANCIPATORY	– TECHNICAL

Figure 1: Summary of Conceptions of Six Aspects of Research into Student Learning (Marton & Svensson, 1979)

The figure above collates the different approaches in each of the aspects and illustrates the varied conceptions among researchers in this particular area of research.

Brew (2001, p. 280) has identified four categories of conceptions, based on what aspects of research are in the foreground and how they interpret what research is. They are Domino, Layer, Trading, and Journey. Based on the implicit variation between different studies, Åkerlind (2008a, p. 17) has identified four foci, representing different dimensions of academics' understanding of the nature of research: research intentions (who is affected by the research), research outcomes (the anticipated impact of the research), research questions (the nature of the object of study), research process (how research is undertaken), and researcher affect (underlying feelings about research). The conceptions can also vary depending on the context of the researcher. In a different study, Åkerlind (2008b, p. 241) has investigated the development of researchers after their PhD and mapped them as (1) Becoming confident as a researcher; (2) Becoming recognised as a

researcher; (3) Becoming more productive as a researcher; and (4) Becoming more sophisticated as a researcher. She argues that the last three categories are seen as relevant to all stages of research career. Both Brew and Akerlind's models will be revisited in Chapter 4 due to their relevance to my study.

The contexts informing various conceptions of research include the institution where they work. Bazeley (2009, p. 19) has provided a typology of academics' responses to institutional research orientation, which links the level of personal commitment to research with the research orientation of the institution.

		Research orientation of the institution	
		Low	High
Level of personal commitment to research	Low	**Non-researcher:** No need for opportunity	**Reluctant researcher:** Only does what is required
	Moderate	**Distracted researcher:** Always something more important to do	**Small 'r' researcher:** Engages in data gathering, projects of local significance, or with team
	High	**Addicted researcher:** Will do it anyway, but may suffer in their personal life as a consequence	**Big 'R' researcher:** Harmony between personal and institutional goals creating possibility of major interpretive breakthroughs

Table 1. A typology of academics' responses to institutional research orientation (Bazeley, 2009)

The table above illustrates that 'harmony between personal and institutional goals creating possibility of major interpretive breakthroughs' happens when the personal commitment and research orientation of the institution are high. Thus, the literature covers a range of conceptions of research and of being a researcher. My study examines the conceptions and experiences of researchers with the lens of technology use.

Researcher development

Researcher development is defined as a 'process whereby people's capacity and willingness to carry out the research components of their work or studies may be

considered to be enhanced, with a degree of permanence that exceeds transitoriness' (Evans, 2012, p. 425). These developments can be behavioural, attitudinal and intellectual, with multiple sub-components such as processual change; perceptual change; analytical change; and comprehensive change (Evans, 2011, p. 22).

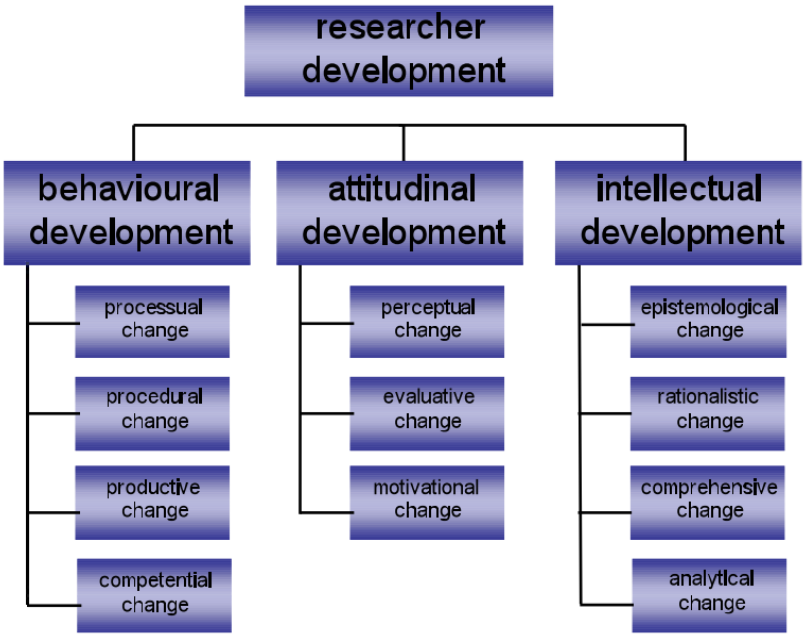

Figure 2: The componential structure of researcher development: 1st and 2nd tier components. (Evans, 2011)

Figure 2 shows the 11 sub-components identified, out of which the Epistemological, Processual and Competential changes are key for my study. Epistemological change is about researchers' understanding about research, researching, and their research area knowledge. Similarly, Processual change is about the practice, as in how they conduct the various elements of research-related activity. Competential change involves the increase or enhancement of research-related skills and competences (Evans, 2011, p. 23). These three are visible in the findings of my thesis in terms of intellectual aspects, process-based aspects, and developmental aspects, with a specific focus on researchers' effective use of technology.

Key issues from relevant studies

It would appear that research leaders experience research as a challenge in many ways, and they often face them individually. It could be argued that researchers feel most strongly

valued for their research activities compared to other leadership, management, impact and engagement activities, and teaching (Mellors-Bourne & Metcalfe, 2013, p. 2). The pressure of producing impactful output is very high in light of the competitive nature of securing the declining funding for research, which is especially worse for non-STEM fields, such as social science. The field of educational research is bifurcated between research production and research reception, and the former is being subordinated to the latter (Colley, 2014, p. 660). Researchers appear to perceive the relationship between their research and policies in individual terms, rather than in terms of being a part of a community (Ashwin et al., 2015, p. 1). They are least likely to feel valued for managing and developing the research staff, motivating and providing them career development advice (Mellors-Bourne & Metcalfe, 2013, p. 2). Hence, there is no impetus for experienced researchers to engage with their team, adding to their isolation.

Ashwin et al. (2015, p. 12) urge future projects to explore the extent to which such lack of collective identity is present among other disciplinary groupings. In an attempt to address this, my study examines the non-STEM researchers' use of technology as a collective than as individuals. As Rees et al. (2007, p. 776) suggest, the starting point for developing new and perhaps more imaginative strategies for research-capacity building is a much better understanding of the conditions under which educational researchers do their jobs and of the wider social relations within which these are situated. My study, thus, focuses on a particular aspect of the bigger picture – the use of technology by non-STEM researchers. The varied conceptions, contexts and challenges illustrated by various studies make this an interesting and important field that requires further research. My research reviews the conceptions of researching among participants and maps it from the perspective of their use of technology.

Researchers and technology use

Using technology in academia

Technology is an enabler now in people's everyday tasks (Lupton, 2014) and computers and smart devices are becoming an indispensable part of life (Sim & Stein, 2016, p. 1). The costs of digital devices, storage and internet bandwidth have fallen over the years, and

audio, video, text-processing and so on are being used daily by people at home, at work, and in formal education (Bell, 2010, p. 526). Initiatives like the Basic Digital Skills Framework (The Tech Partnership, 2017) ensure that citizens can achieve the same minimum standards in managing information, communicating, transacting, problem solving, and so on. Studies show that we are all the Google generation, regardless of our age, and have changed the way we seek information (Rowlands et al., 2008, p. 308).

The scope and nature of technology-enabled change that is possible and desirable in different educational sectors and societies is an area worth researching (Bell, 2010, p. 533). There is already a large number of papers on technology in academic settings, describing how it successfully enables new pedagogical and practical approaches (Clegg, 2011, p. 177). There is also a significant body of research on exploring how technologies can be used to support all aspects of Higher Education practices – learning and teaching, research, and administration (Conole & Alevizou, 2010, p. 42). For example, Kirkwood and Price (2014) have provided an evaluation of literature and report how the enhancement by technology is conceived in related studies.

In terms of research, technology-enhanced learning systems can also function as useful research instruments and can be combined with powerful process-analysis support tools, to provide deep insights into the learning process (Cox, 2007, p. 353). For example, e-Science, e-Social Science, etc. in research give fascinating insights into exploitation of large, distributed research datasets and, more recently, into the use of cloud computing (Conole & Alevizou, 2010, p. 42). Such advancements have made fundamental shifts in qualitative research methods, offering the potential for more accurate, efficient and trustworthy representations of qualitative data (Markle, West, & Rich, 2011, para. 48). Although contested later in this thesis, it has been suggested that academia has been quick to grasp technology affordances as well as recognise the negative impacts; particularly in research, the digital cornucopia of resources have been welcomed (Clegg, 2011, p. 186). In terms of scholarship, the proliferation of fast and out-of-control technologies presents both a challenge and opportunity for existing practices (Weller, 2011, p. 10), making this an area of interest to research further. Although I will draw on studies that do not necessarily delimit the findings based on 'research age' (for example PGR or

research leader), my main focus of review will be on experienced researchers and their use of technology.

Discipline differences and use of technology

The pattern of discipline differences discussed earlier also exists in the context of how technology is used for research in non-STEM areas. In some studies, the gulf between the 'social' and the 'technical', thus between the social sciences and natural sciences, and engineering is seen as artificial (R. Williams & Edge, 1996, p. 893). However, there is a counter argument that researchers' uses of, and attitudes towards, digital technologies are affected by the existing disciplinary habits and preconceptions; besides the computational and collaborative complexity of the tools that researchers used was linked to their disciplinary backgrounds (Collins, Bulger, & Meyer, 2012, p. 76). Where possible, there are often workarounds to make the best use of technologies across disciplines. For example, a communication application developed for the e-Science community can be repurposed for application within the social sciences, whereas tools focused on the collection and analysis of data, however, may require more translation to cross from, say, the physical to the social sciences (Dutton & Meyer, 2010, p. 169). Such use of technology seems to be limited, as there are concerns of the research becoming interdisciplinary. The literature acknowledges a strong perception, especially among the Social Science and Arts & Humanities researchers, that the recruitment and promotion criteria are more easily evidenced through monodisciplinary research; thus, promotion and tenure policies in HEIs discourage IDR (Davé et al., 2016, p. 9). Such conceptions can create caution and apprehension when using technology for non-STEM research, as excessive use of technology could lead to making their study an IDR, thus might potentially devalue themselves.

Key ideas and terms referring to technology use

The use of technology is referred to in a range of ways in the literature. Numerous national programmes have aimed at encouraging researchers across all disciplines to make use of e-Infrastructures (Procter, Voss, & Asgari-Targhi, 2013, p. 1668). Depending on the national funding contexts, studies refer to technology use as e-Science, e-Social Science, digital humanities, cyberinfrastructure and many other terms (Dutton & Meyer, 2009, p.

223). Such variation can be viewed in two strands, with an emphasis on 1) infrastructure and discipline, and 2) skills and applications.

From the first strand – 'infrastructure and discipline' – of technology use, the term e-Science refers to a variety of technologies and covers high performance, large scale, and grid-enabled computing, and the shared data and computational resources used in these technologies (Terras, 2009, section: Notes). The term e-Research has been used to capture the work across disciplines as diverse as astrophysics and the study of ancient documents, and is thought of as a more inclusive term, covering all kinds of research than just within the sciences (Oxford e-Research Centre, 2016, section: e-Science vs e-Research). E-Infrastructure refers to innovative digital information and communication technologies (ICTs) that are networked, interoperable, scalable and able to provide access to remote resources, which can be used to compute resources, data or instruments, and facilitate collaborative research across disciplinary and organizational boundaries (Procter et al., 2013, p. 1668). Technology-enhanced research is another term (Cox, 2007; Matthews & Cramer, 2008) which focuses on research rather than the technology, while the term e-Infrastructure (Barjak et al., 2009, 2010; Procter et al., 2013) could be seen as alerting and inviting the researchers to a potential resource they could benefit from.

From a discipline specific view, e-Social Science, Digital Humanities, Cybersociology, Digital Anthropology, Digital Sociology, and so on are the terms in use. The term Digital Sociology seems to offer a means by which the impact, development and use of these technologies within the social worlds may be investigated, analysed and understood (Lupton, 2012, p. 4). Digital Humanities applies similar approaches in humanities and sees it as part of Digital Scholarship (Raffaghelli, Cucchiara, Manganello, & Persico, 2016, p. 2). Alluding to the discipline differences, the Social Sciences and Humanities (SSH) communities demand that they have to be accepted as being distinct and not suited to the 'one size fits all' strategy of e-Infrastructure diffusion (Barjak et al., 2009, p. 583).

From the second strand – 'skills and applications' – of technology use, the terms used include Information Literacy, Digitality, Digital Literacy, Technological Literacy, Digital Inclusion, Digital Scholarship, Networked Participatory Scholarship, Digital Ethnography,

Digital Hermeneutics, and so on. The term Information Literacy, in the context of my study, focuses on researchers collaborating, creating and publishing information using digital technologies (Bent et al., 2007; Bent & Stubbings, 2011). In a similar sense, Digitality refers to the systematic use of digital tools by scholars (Goodfellow, 2014, p. 4). The term Digital Literacies encompasses a range of other capabilities, including digital scholarship and ICT Literacy (JISC, 2014, figure: Seven element of digital literacies), while Technological Literacy means the researcher must understand the nature of technology, have a hands-on capability and capacity to interact with technological artefacts, and be able to think critically about issues relating to technology (Collier-Reed, 2006; Ingerman & Collier-Reed, 2011). This criticality is at the heart of the term Digital Scholarship, when it refers to the curation and collection of digital resources, placing it in the information sciences; however, it also covers a range of scholarly activities afforded by new technologies (Weller, 2011, p. 43). In addition, it includes cyber infrastructures supporting new forms of doing research and science, namely e-Research and e-Science (Raffaghelli et al., 2016, p. 2). Networked Participatory Scholarship is another term that focuses on the relationship between scholarly practice and participatory technologies in engaging with relevant communities (Hicks, 2016; Veletsianos & Kimmons, 2012). Finally, the infiltration of technologies into popular sociological research methods has led to the invention of terms such as Digital Ethnography (Murthy, 2008, p. 837) and Digital Hermeneutics (Capurro, 2009; Tripathi, 2016). In summary, the terms referring to the role and use of technology are hugely varied.

The 'infrastructure aspects' above focus on the tools researchers could use, while the 'scholarship and discipline aspects' focus on the research fields. The literacy aspects above focus on the information behaviour and its use, rather than the technology per se. In such foci, the experiences and issues around the tools used to manage the information have a limited focus. In other words, the literacy, scholarship and discipline aspects have the end (information) in focus, not the means (the tools), which in turn is the focus of the infrastructure aspects. In my study, the focus is on how the 'means' (technology and infrastructure aspects) are used in their research.

Tools and technologies used

Researchers' choice of tools and technologies spans over a wide range – from low-tech options, such as pencil and paper, to high-tech options, such as digital video (Tannen, 2008, pp. 74–76) and high-performance computing (Terras, 2009, para. 12). The range also covers internet-based tools and social media to support the academic research process (Sumner, 2012, p. 171). The demand for new tools comes from funders as well as researchers themselves, wanting to capitalise on the possibilities of the internet for collaboration (Bosman & Kramer, 2015, para. 3). There is now an increasing usage of online social media tools among researchers for research and networking activities (Aresta, Pedro, Santos, & Moreira, 2015; Bampton, Cowton, & Downs, 2013; Berg, 2012; Dutton & Meyer, 2010; Minocha & Petre, 2012; Sumner, 2012; Veletsianos, 2013). It is recognised that no technology is a substitute for skill and technique; however, these tools can improve the speed, validity and benefits to research (Tannen, 2008, p. 76). Although Dutton and Meyer's (2009, p. 249) study has found great diversity in the range of tools employed across their sample of 526 researchers, they assert that there is unlikely to be any killer application for researchers.

Foci and approaches of relevant studies

Studies examine the rationale and drivers for researchers to consider the use of technology for their research. Policies and frameworks have a limited effect on researchers and studies about researchers. The European and UK policies and initiatives emphasise the social and economic relevance of e-Infrastructure for research and ambitiously encourage the researchers to develop relevant skills (European Commission, 2015). Researchers are expected to willingly learn and develop additional skills and capabilities in interactive communication technologies, multimedia and web tools for networking, information/data sharing and promoting research presence (Vitae, 2011). The Research Lens of 'Seven Pillars of Information Literacy' helps with this, preparing researchers for the technology era and focusing on various stages of dealing with information, such as to identify, scope, plan, gather, evaluate, manage and present (Bent & Stubbings, 2011, p. 12).

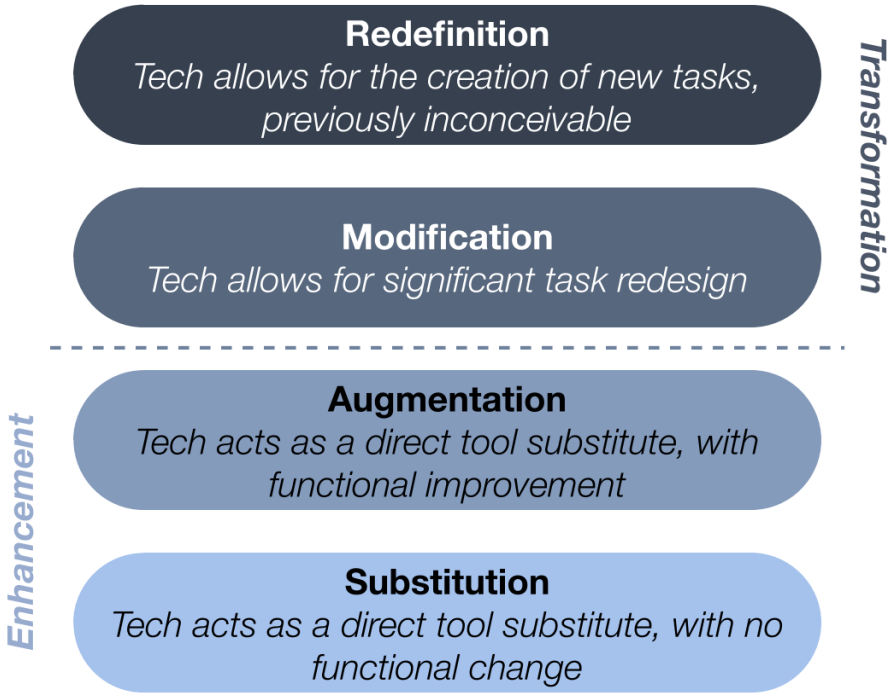

Figure 3: SAMR model (Puentedura, 2013)

Expectations of enhancement and transformation

Studies show huge expectations on technology, from enhancing to transforming research. Figure 3 is the SAMR model (Puentedura, 2013, p. 5), which shows how technology is adopted in teaching and learning through substitution, augmentation, modification and redefinition. This model could be used to map technology expectations in the context of research as well. Within the first level of 'substitution with no functional change', there is an expectation for research activities to benefit in terms of moving from the pencil and paper to use ICT for documentation, measurement, efficiency, enhancement and making significant savings of time and financial resources (Bampton et al., 2013; Tannen, 2008). Moving on to the next SAMR level – 'augmentation with functional improvement' – there are studies that refer to improving the ability to observe, collect, process and visualize information (Dutton & Meyer, 2010, p. 173); extending the period of communication (Bampton et al., 2013, p. 338); working with data in its original multimedia format to improve rigour (Markle et al., 2011); and gaining enhancement through video-based research design (Arnold & Clarke, 2012, p. 7).

In the transformation half of SAMR, technology is expected to contribute in the 'significant redesign' of research activities. Here, the expectation includes the use of big data in disciplines such as social sciences (Gibbs, 2014, para. 1); an increase in the geographical or social reach of the researcher's resources (Bampton et al., 2013; Dutton & Meyer, 2010); and high performance computing to allow large datasets to be searched and analysed quickly, efficiently, and in complex and novel ways (Terras, 2009). In the most advanced SAMR level, technology transforms the research by 'defining and creating' new research approaches and activities. Examples of such expectations include enabling social scientists to go where no other research has gone before (Dutton & Meyer, 2010, p. 173), by creating new sources of data (Dutton & Meyer, 2010, p. 169); employing more exciting array of methods, enabling them to demarginalise the voice of respondents (Murthy, 2008, p. 837); and developing new research methodologies (Weller, 2012, p. 357). Interestingly, the literature in 2008 refers to employing the methods unavailable to their counterparts a few years ago and includes blogs and wikis (Rowlands et al., 2008, p. 305), alluding to the 'transformational' half of SAMR. However, now 10 years later, these are beginning to drop to the 'enhancement' half of the SAMR model or even become the researchers' norm. Hence, it is important to note that as time goes by, diffused innovations and expectations from researchers can go down to lower levels of the SAMR model to become just a modification or even augmentation of how they normally use technology.

Applications of technology for research activities

The ways of using computers and software in the context of qualitative research have been outlined by Miles and Huberman (1994, p. 44) more than two decades ago, and their list of 14 processes include activities such as making notes in the field, editing, coding, storing, analysing, theory building, graphic mapping, and final reporting. Interestingly, Dutton and Meyer's (2010, p. 168) grouping of research activities across various phases of the project in 2010 has not deviated much further. Nevertheless, introduction of internet has contributed to networked computer technologies, use of smart phones for email, social networking, and use of search engines (Bosman & Kramer, 2015; Dutton & Meyer, 2010; Igoe, 2012; E. A. Williams & Anderson, 1999). These new affordances of technologies have brought additional research processes, such as Digital Preservation, Data Quality,

Data Security, Open Access, besides working with Virtual Research Environments (Karagiannis et al., 2013, pp. 3–5), as well as providing a valuable resource for the development of theory (Friesen, 2010, p. 83). Diffusion of technology in society now means that what used to count as 'the social' is now increasingly enacted via digital technologies (Lupton, 2014, p. 188). This opens new research areas and processes, such as sociological analyses of digital media use and reflexive and critical analyses of digital media, informed by social and cultural theories (Lupton, 2012, p. 5).

Researchers' adoption of technology

Although there are very limited studies on researchers and technology adoption some literature provide useful insights. It is suggested that, for successfully facilitating a technology adoption, the cognitive, emotional, and contextual concerns need to be addressed (Straub, 2009, p. 626). Wider adoption of particular technologies leads to its diffusion. Dutton and Meyer (2009, p. 224) draw on four alternative theoretical expectations about the diffusion of e-Research tools and techniques: research cohorts, methodological politics, certainty trough, and experience technologies. It is useful to have a closer look at these expectations as discussed below. An explanation for the first expectation is that the diffusion of technology among 'research cohorts' will depend on the exposure to technology they have had, and greater innovative practices over time would result in newer cohorts replacing their more conservative elders, who may not use technology. The 'methodological politics' expectation alludes to the compatibility of methods leading to positive attitudes toward e-initiatives, where non-STEM disciplines are not as amenable as STEM disciplines. 'Certainty trough' suggests that while researchers who are committed to technology would certainly use it, the other two groups – those who are not aware of technology and those who are aware but also know its pitfalls – would be less certain about using it. However, 'experience technologies' is the opposite idea – that experience and exposure to technology foster the use of technology (Dutton & Meyer, 2009, p. 225).

Straub (2009, p. 628) identifies three categories of characteristics that influence the adoption and/or diffusion of an innovation shared by most theories. These categories of characteristics – individual, technology, and context – have informed my study and are

applied in Chapters 4 and 5. However, the uptake of digital literacy training and development activities is restricted by barriers such as time, opportunity and cost (Igoe, 2012, section 4: Conclusion). Hence, motivating researchers to try technologies is important. Some researchers genuinely do not want to use technology. With regard to digital technology, there are not only 'have-nots' (do not have access), but also 'want-nots' (do not want access). This is a much neglected phenomenon, and research among non-users and the unconnected is relatively scarce (van Dijk, 2006, p. 226). Weller (2011, p. 13) argues that even if an individual does not engage with new technology, its adoption by others begins to change the environment within which they operate. This highlights the need for further studies, especially on the frontline experiences of researchers and their adoption and usage of technology.

Ethics of technology use

The literature about the use of technology recognises three types of ethical concerns. First, the technology-enhanced research designs already come with a set of ethical and moral implications, including data privacy, confidentiality, and security; accessibility of computers and the internet; transparency of motivation and trust on the researcher; and the level of involvement with participants, and collaborations across disciplines and even outside the academy (Hesse-Biber, 2011; Matthews & Cramer, 2008). Secondly, the new online techniques raise further ethical considerations in terms of suitability of the 'human subjects model' to inform online research: how to understand and respect privacy in public domain (for example, social media); the extent to which researchers should be able to collect and disseminate all the online data that are available to them; the implications of aggregating and combining multiple data sets; the consequences of using academic data for commercial purposes (and vice versa); and the need to accommodate the different cultural, legal and social contexts of the people who participate in such studies (Eynon, Schroeder, & Fry, 2009, p. 197). Finally, in more advanced cases of the use of technology, such as artificial intelligence, there is a need for further ethical caution, which involves human-computer interaction. The operation of heuristics to explain complex mental phenomena, and then the use of that learning to design and develop tools for facilitating and developing new artificial mental processes raise a kind of epistemological and practical 'conflict of

interest' (Friesen, 2010, p. 83). These three levels of ethics are well acknowledged and accepted across the literature; however, ethics was not a critical aspect of how the use of technology was experienced by my participants as discussed in Chapter 7.

Interplay and effects of technology use on research and researchers

Studies on technology use in research often refer to the interplay and effect that technology use has on researchers and their behaviours. The literature emphasises the individual nature of researchers in the context of technology use in social science (Dutton & Meyer, 2010; Meyer & Dutton, 2009) and shows that it has implications for the development of 21st century academic identity (Kirkup, 2010; Sumner, 2012). Although digital technologies provide collaborative tools to create and share information (Bent & Stubbings, 2011, p. 8), the usage amongst researchers appears to be low (Igoe, 2012, section 4. Conclusion). Many cases of technology use involve a sole researcher as opposed to working in collaborative teams. This is congruent with the study of Meyer and Dutton (2009, p. 245), who have found four types of e-Researchers and behaviours: Lone e-Researchers, Team Players, Quals, and Quants. Their study also highlights that qualitative methods are often used by a sole investigator, which is common among non-STEM researchers such as social scientists. There has been some evidence of technology use having an effect on intellectual aspects of research – for example, information-processing technology shaping the thinking (Perkins, 1985), and emerging technologies leading to new research questions and areas of inquiry (Hesse-Biber, 2011, p. 3). In summary, there are some evidences of the effect on intellectual aspect of research. Also, the researchers' use of technology seems to be a solitary process.

Issues, barriers and challenges

Weller (2011) warns that technologies are transforming scholarship into a digital one; but, there are tensions around existing and new practices. Widening adoption of e-Infrastructure into everyday research practices is a struggle because technologies are seen as complex and challenging; users often experience frustrations; and, some potential users may be unaware of its benefits to take even the first steps towards exploiting them (Procter et al., 2013, p. 1668). Infiltration of technologies into popular sociological research methods is still

limited (Murthy, 2008), and there is currently limited reference to software or numeric techniques in the use of qualitative methods in social research (Gibbs, 2014, para. 2). There are strong sentiments around the importance of human interventions, such as face-to-face contacts, and many researchers agree that such fundamental elements of human interventions cannot be replaced by technology (Harley, Acord, Earl-Novell, Lawrence, & King, 2010, p. 16). It is interesting to note that despite all the advanced use of technology to produce excellent research, the research outcomes still continue to be in HTML web format or PDF publications, reflecting on the analogue past (Bourne, 2011, p. 119). In addition, the piecemeal use of ICTs, that too only within specific stages of research, has limited the degree to which the new tools can be taken into full advantage (Dutton & Meyer, 2010, p. 180).

The benefits of technology use are often experiential in nature; so users have to engage with them over a prolonged period to appreciate their value and the nature of interactions (Weller, 2012, p. 350). Another challenge is to manage the technology and stop its ease of use from leading to overuse, such as collecting more data and resources than researchers can organise, analyse and communicate (Tannen, 2008; Thomson, 2015). Vulnerability to technical problems, potential loss of human emotional elements in interactions, and any related ethical issues of privacy would also need to be compensated (Bampton et al., 2013, p. 339).

The fundamental barrier is the recognition of digital scholarship as an activity that is worthy of appreciation, which is distinct from concerns around how best to represent and measure it (Weller, 2012, p. 350). Using technology to enhance scholarly practice has been met with scepticism and reluctance (Veletsianos & Kimmons, 2012, p. 767); sometimes, the supervisors even block the adoption of technologies (Minocha & Petre, 2012). In effect, enthusiasm for the development and adoption of technology is not associated with the hard reality of tenure and promotion requirements (Harley et al., 2010, pp. 12–13).

Researcher development and technology use

Although limited, the literature refers to researcher development in terms of their technology use. Hammond and Hawtin (2011, para. 4) clarify that digital technology

support requirements for STEM and non-STEM research are not very different, but requires different types of solutions for the different problems and stages. Clearly, the researchers adopt the digital tools and platforms to manage their research workflows; however, they need to develop new technical expertise in order to bridge the perceived skills gaps (Mackenzie & Martin, 2016, p. 175). Importance of digital literacy development, especially through some targeted training, has been recommended by various studies (Beetham, 2010; Igoe, 2012). There are some criticisms that the current digital literacy training provision within and outside higher education institutions is limited and not seen as relevant to researchers (Igoe, 2012, section 4. Conclusion). A range of discrete activities, for example, technical support, requirements capture, networking and matchmaking, outreach and promotion and training, are all recommended as different ways of engaging researchers in development activities (Hammond & Hawtin, 2011, para. 8). However, it has been acknowledged that institutions should accept that some advanced use of ICT should be left to the researchers to support themselves (Hammond & Hawtin, 2011, para. 18). In fact, researcher development in this context is also about their discernment of selecting the right technology for their research. Researchers should be cautious about adopting new technologies too quickly; reliability and simplicity could be the priorities for research tools, so that they do not interfere with or impede the research (Tannen, 2008, p. 76). There are some approaches to help researchers with this. For example, the G-E-O model could be used to evaluate whether a tool makes the research Good, Efficient or Open (Bosman & Kramer, 2015, para. 4); similarly the three-e strategy (evident, easy to use, and essential) could be used for overcoming resistance to technological change (Haymes, 2008).

Key observations

Recent studies pay limited attention to how ICT integration happens in the process of research (Sim & Stein, 2016, p. 8). Digital scholarship is still in its infancy and is advancing in a rather fragmented way (Raffaghelli et al., 2016, p. 1). Although researchers who use digital technologies are largely confident and positive (Igoe, 2012 section 5. Vitae recommendations), there are senior managers and professors who have only a limited understanding of the new forms of scholarly practice that utilise different media and technologies (Weller, 2012, p. 351). Promotion of e-Research is done cautiously over

researchers' concerns about effects of technological changes on existing practices (Dutton & Meyer, 2009, p. 224; Procter et al., 2013, p. 1669; Raffaghelli et al., 2016, p. 3).

There are also risks in the uneven uptake of e-Social Science across methods, between academia, and the commercial world (Dutton & Meyer, 2010, p. 178). Scholars trained in both an academic field and in a particular new technology or tool are important to advancing new research agendas (Harley et al., 2010, p. 27). The challenge is not actually the technology or associated skills but developing a mind-set that is collectively comfortable and resilient to the changes that technology use brings (Mackenzie & Martin, 2016, p. 175). Supporting conceptual change should, therefore, be a central component of professional development activities (Englund, Olofsson, & Price, 2017, p. 73). Examining why e-Social Science and similar disciplines have used technology in a limited number of ways might contribute to understanding the limits of the use of these tools and the patterns of awareness of these applications (Dutton & Meyer, 2010, p. 179). It is important to track how social scientists do what they do to study the trends in research practices and engagement with e-Research (2010, p. 180). Whether the low usage is due to lack of relevant provision for researchers or lack of their interest requires further investigation (Igoe, 2012 section 5. Vitae recommendations).

Lincoln and Guba (1985, p. 352), in their seminal text *Naturalistic Inquiry*, note how computers were adapted back in the late 1970s to deal with the mechanical phases of research, such as retrieve, modify and transform data, but not so much with the interpretive phases of it. Surprisingly, the literature review shows that apart from some isolated and disparate efforts, even after nearly four decades, the technology used by researchers are still not able to do much more than those mechanical phases of research. It would appear that digital technologies and media are not necessarily changing what researchers 'do' as researchers, but how they do their research activities and changing what it means to be an effective researcher (Igoe, 2012, section 4. Conclusion). Rather than asking how emerging technologies will transform scholarship, we could ask what the emergence and use of such tools reveal about scholars, in terms of how knowledge is being acquired, tested, validated, and shared (Veletsianos & Kimmons, 2012, p. 769), and perhaps created too. The question remains whether researchers will be ready with progressive methods to take advantage of

the emerging tools (Markle et al., 2011, para. 49) and this is one of the central themes that drives my study.

Chapter conclusions

Experienced researchers are an understudied population. The literature shows some evidences of the varied nature of being a researcher and engaging in various research related tasks, including intellectual and process-based activities. In addition to being a researcher, they have other roles of a scholar, teacher and administrator. The literature on the research-teaching nexus suggests there is lesser collaborative work in research compared to teaching. The focus appears to be on themselves as individual researchers rather than as a member of a broader community.

In terms of use of technology, the literature highlights varied understanding and references to technology and its applications from pencil to e-Infrastructure, information literacy to technology literacy, and its application in specific disciplines such as digital sociology. There has been no clear definition of what technology is for researchers. Rather, it has been conceptualised as an extension of the researcher other than themselves and its use enables them to do a research activity or benefit from it or complement their research. Nevertheless, for this study, 'technology' was broadly defined as tools and resources that enabled and supported research activity. The term 'use of technology' has been conceptualised as the knowledge, discernment and application of such tools and resources.

Although research is not the same as scholarship but just a part of it, studies on technology use do not make this distinction. Technology is seen as an enabler and government and the funding bodies encourage its use and adoption. Vitae and Jisc are the key and only consistent and persistent bodies that continue to work in the area of research and researchers, and technology use for academia, respectively. Although non-STEM researchers' technology use is different than STEM researchers', its value is well recognised in the literature. Interestingly, although technological advances have been made and expectations are high, researchers seem to apply technology (old or new) for the same types of processes and applications over the past 40 years. There are some

evidences of technology use enabling and informing research, although research informing the development of technology for research is very limited.

In summary, there is considerable variation of experiences among researchers in how they conceptualise research and related activities. The literature shows that the use of technology is valued by researchers. However, inconsistent references and conceptions of technology use, the wide range of tools used by researchers, their uneven usage, and disparate studies about the relevant issues make this field of study chaotic. Researcher development programmes also discuss and approach technology use in varied ways. This means, researchers will also have varied understanding and conceptions, leading to different ways of seeing and using it. Hence, it is important to understand those varied conceptions and how they are related or differentiated. Mapping such variations of individual experiences provides an understanding of how researchers conceptualise and experience technology use, and this is the central question that my study aims to address.

Chapter 3: Research methodology

Introduction

This study aimed to analyse non-STEM researchers' experiences and conceptions of technology use in their research. From the limited relevant literature available, the previous chapter has established the importance of understanding researchers' varied experiences of conducting research and using technology. Key factors emerging from the literature were: inconsistent references and conceptions of technology use; the wide range of tools used by researchers; and their uneven usage and disparate studies about the relevant issues and experiences. In other words, there was considerable variation of experiences among researchers in how they conceptualise research and related activities including use of technology. My study aims to analyse and map those varied experiences and how they are differentiated or related.

In terms of implementing my study, this chapter begins with the conceptual framework which provides an overview of the context, theories and methodology used. It then critically introduces the phenomenographic orientation before clarifying the theoretical framework used in this thesis. An explanation of the design including the ethical considerations are provided. In accordance with phenomenographic tradition, a critical commentary of the style of analysis adopted, and how it weaves template analysis into the process to address the research questions, are discussed. Finally, the chapter explains how the findings are presented in the subsequent chapters and discusses the trustworthiness of the approach.

Conceptual framework

A conceptual framework explicates the relationships within the research context, the theories and methodology that have been utilised, as well as the conceptual conclusions. In other words "conceptual frameworks offer a self-audit facility to ensure cohesion and appropriate conceptualisation for research conclusions" (Leshem & Trafford, 2007, p. 101). This section outlines how my study is conceptualised and demonstrates a cohesive approach.

There has been considerable growth in the adoption of technology within higher education since 1990 (Kirkwood & Price, 2014, p. 12). Researcher's experiences of using everyday tools, such as word processing, can vary in terms of both experiences and task. The huge range of tools being used in so many varied ways in research makes it difficult to map the experiences and understand the broader picture of using technology. This is where a phenomenographic approach is helpful, especially in an understudied area. It provides a framework to ground the study in participants' descriptions of experiences and identify the qualitatively different ways that these experiences happen. However, phenomenography does not stratify individuals into particular categories of experiences.

Phenomenography has been used to study technology related topics and the phenomena has focused mostly around teaching and learning, information and digital literacy and technology in general (Collier-Reed, 2006). It was also used to study students (Marton, 1986; Reed, 2006; Souleles, Savva, Watters, Annesley, & Bull, 2015), post-graduate researchers (Bruce et al., 2009; Stubb et al., 2014), as well as researchers in general (Åkerlind, 2008a; Ashwin et al., 2015; Brew, 2001). One of the methodological contributions of this thesis is using phenomenography with a combination of experienced researchers to understand their experience of using technology for researching.

My study examined a small sample of experienced non-STEM researchers and analysed their accounts of using technology for carrying out their research. The focus was on the variations among the group rather than on their individual experiences. The three themes from the research questions were: researchers' experience of doing research; the key characteristics of the technologies they use for research; and the varied ways in which they experience the use of technology. The study adopted a non-dualist ontology in which the epistemological interest is situated in understanding the varied experiences and perceptions of technology use.

A phenomenological strategy was adopted, and more specifically phenomenography (expanded below) was suitable as it focused on the variation among a group of people rather than focusing on individuals or the overall essence of the phenomenon as in phenomenology. Theoretically, phenomenographic orientation draws on Gestalt

psychology (Larsson & Holmström, 2007, p. 63; Linder & Marshall, 2003, p. 273) and Brentano's intentionality (Marton & Booth, 1997, p. 84) as well as builds on Gurwitsch's structure of awareness (Gurwitsch, 1964, pp. 341–344) with its modification by Marton and Booth (1997, pp. 98–99).

According to phenomenography, a conception of an individual can be characterised as composed of both a referential aspect and a structural aspect, where the former is the meaning of an object that has been delimited and attended to by the individual; and the latter is the combination of features they have discerned and focused upon (Marton & Pong, 2005, p. 336). Phenomenographic analysis approaches the conceptions of a group of individuals as a collective rather than separate individuals, and the outcome is the meanings of varied experiences (referential) and the critical aspects of those variations (structural). Thus, the outcome of this study is the structural and referential aspects of researchers' experience of using technology. A detailed discussion of all these elements are covered in the sections below including the research design, implementation, presentation of findings and trustworthiness (qualitative equivalence of validity, reliability, and generalisability).

Phenomenographic orientation

Non-STEM researchers' use of technology is an understudied area and hence it was appropriate to start with getting a broader sense of the key issues among this population. Phenomenography is suitable for such an approach as it is concerned with a group of people rather than individuals whilst the rationale lies in being faithful to individuals' conceptions of an aspect of reality to better understand human action within society (Sandbergh, 1997, p. 204).

Examining how researchers experience technology use can help to understand how they use the technology in their relevant contexts. This is in line with Marton and Booth's suggestion that:

> …in order to make sense of how people *handle* problems, situations, the world, we have to understand the way in which they *experience* the problems, the situations, the world, that they are handling or in relation

> to which they are acting. (Marton & Booth, 1997, p. 111) (Original emphasis)

Here, it means, to understand how researchers use and adopt technology, we first need to understand how they are experiencing and thus conceiving technology use in research. For example, a researcher's use of technology might be informed by the needs of their research. At the same time their experience of using technology could vary depending on the context or a specific situation. Marton and Booth (1997, p. 83) argue that our awareness of a situation is moulded and understood in terms of the phenomena involved; and similarly "our experience of the phenomena is modified, transformed, and developed through the situations we experience them in". This shows the relational nature of the experience which is at the heart of phenomenography.

In this research, technology use is the phenomenon. The situation, for example, could be using a word processor to edit and insert a chart in an article. It could be argued that a researcher's experience of this situation is shaped by the use of the word processor and its characteristics or affordances. Equally, their experiences of using the word processor are also changed by the need to add a chart that they may not have done before, or may be doing it easily for the hundredth time. This shows that the experience of the phenomenon (technology use) is subjective and interrelated to the context and the subject (the researcher). However, at an ontological level, this experience may appear to have no difference for a second researcher who sees that a chart is being added. It could be argued that the second research's experience with the word processor will be interrelated to the situation they will be using it and hence subjective to that researcher. Yet again, from a third researcher's perspective, the reality of these two varied experiences could be similar. In essence, there will be numerous variations in experiencing the technology use that is experienced differently by different researchers. To understand such experiences, however, it seems useful to uncover what is common and what varies between the researchers' experiences and the ways in which they are qualitatively different. This can be achieved through a phenomenographic analysis.

Even after nearly 50 years since its formation (Pang, 2003, p. 145; Svensson, 1997, p. 159) phenomenography is still a relatively new research specialisation in terms of number

of studies (compared to phenomenology) or wider acceptance among scholars. Collier-Reed, Ingerman, and Berglund have provided a comprehensive and succinct summary of 'Phenomenography' which encapsulates its key points:

> Phenomenography as a research tradition is located broadly within an interpretive epistemological orientation and focuses on the variation in how a phenomenon is experienced by a group of individuals. Phenomenography is underpinned by, amongst others, a focus on the relational nature of human experience, a non-dualistic ontological perspective, an explicit focus on the experience of phenomena, and the adoption of a second-order perspective. The research outcome is a set of categories that describe the qualitatively different ways of experiencing that phenomenon, and are logically related in structure and meaning. The categories are not descriptive of how individuals perceive the phenomenon – rather they describe the phenomenon at the collective level. Learning, in the phenomenographic tradition, points to coming to discern phenomena in new and more powerful ways (Collier-Reed, Ingerman, & Berglund, 2009, p. 340).

In summary phenomenography is an interpretive, relational, and non-dualistic second-order perspective that aims to describe how people experience a phenomenon in a logically related but varied ways. The analysis is done at a collective level and the variation is explained as individual's ability to discern key aspects of a phenomena. The benefit is argued as developing the ability to discern phenomena in new and powerful ways by understanding other ways of experiencing the same. These details are expanded and explained below taking the context of this thesis into account. The first thing to note is that in phenomenography the word 'experience' is used in a broad and interchangeable way, mainly referring to 'conception' (Marton, 2000, p. 104) but also synonymously with interpretation, perception, understanding, apprehension, etc. (Marton, 1981, p. 178, 2000, pp. 104, 105).

Phenomenography aims to reveal the qualitatively different ways of experiencing various phenomena (Marton, 1986, p. 31; Marton & Booth, 1997, p. 136). It was developed during the early 1970s by a research group in the Department of Education at the University of Gothenburg in Sweden (Pang, 2003, p. 145). The word 'phenomenography' was coined by Marton (1981, p. 180) and it derives from the Greek words 'phainemenon' and 'graphein', meaning appearance and description, as such "phenomenography is thus concerned about the description of things as they appear to us" (Pang, 2003, p. 145). The goal was to

identify a “qualitative, nondualistic research approach that identified and retained the discourses of research participants and focused on people’s understanding of their experience of the world around them” (Barnard, McCosker, & Gerber, 1999, p. 212). Phenomenography can be used to study various phenomena around us and Marton and Booth (1997, p. 136) suggests that “there are logical relationships between different phenomena as they are experienced”. This means a “complex of categories of description depicting the differing ways in which various phenomena are experienced” is possible and the path of phenomenography is to reveal the collective mind or collective anatomy of awareness by analysing various phenomena in the world (Marton & Booth, 1997, p. 136).

Although seeded in the earlier seminal work of Marton and Booth (1997) titled *Learning and Awareness*, eventually, two stable strands or domains of research evolved out of the phenomenographic research tradition namely Variation theory of learning and Learning Study approach (Pang & Ki, 2016, p. 323). Variation theory says “for certain aspects of a phenomenon to be discerned, one must experience variation in those aspects” (2016, p. 325). Whereas in Learning Study practice “teachers work collaboratively to organise learning instances of a particular phenomenon according to the variation and invariance along certain dimensions of variation to bring learning about” (2016, p. 323). The concepts around variation theory are drawn upon later in this thesis to discuss the findings.

Ontological and epistemological positions

Research perspectives or paradigms (Kuhn, 1996) can be seen as “particular sets of lenses for seeing the world and making sense of it in different ways” (Sparkes, 1992, p. 12). Mapping such different ways of experiencing the world or phenomena is at the heart of phenomenography. It employs a non-dualistic constitutionalist perspective where learning is an internal relationship between the individual and the world through the individuals' awareness of the world (Marton & Booth, 1997, p. 13; Trigwell & Prosser, 1997, p. 242). Aligning with my ontological position phenomenography sees a single world which can be experienced differently by different people. For example, the world of an adult could be different compared to that of their child. The adult might be a professional at their work place but a parent to their child. However, there is always only one person in the single

world that is experienced differently by the person themself and their child. The assumption is that the only world that we can communicate about is the world we experience as experienced (Sjöström & Dahlgren, 2002, p. 340). Marton and Booth (1997, p. 13) argue that a researcher should be open to issues that affects their participants and not what affects them as researchers. The researcher's role is to take the experiences of people seriously and explore "the physical, the social, and the cultural world they experience" (1997, p. 13) and use a phenomenographic approach to report the variations of people's perceived worlds (Sjöström & Dahlgren, 2002, p. 340).

Epistemology of phenomenography has a focus on its ontology. Since the research object has the character of knowledge the ontological assumptions in this case also become epistemological in a general sense (Svensson, 1997, p. 167). In other words, the theme of phenomenography is about understanding the perceived world among people rather than the people themselves (Marton, 1981, p. 195). The epistemological position suggests a range of options including phenomenological approaches (Willig, 2008, pp. 154–155).

Phenomenographic epistemology lies in the communication in terms of description of people's thinking about their world as a collective, and its meanings and structure of meanings is congruent with the non-dualistic constitutionalist perspective (Trigwell & Prosser, 1997, p. 242). Thus phenomenographic knowledge focuses on the descriptions of individuals' experiences as a group which fits with my research aims. In terms of epistemological considerations, depending on the context, use of constructionism is suggested "where the focus includes 'the collective generation [and transmission] of meaning'" and use of constructivism when "focusing exclusively on 'the meaning-making activity of the individual mind'" (Crotty, 1998, p. 58). Phenomenography focuses on the experiences of individuals as a group rather than separate individuals. Although the aspect of collective understanding is emphasised here, epistemologically, phenomenography actually focuses on the experiences, meanings and conceptions of individuals, not the process of generation of meaning and knowledge of the group. The group aspect comes to the fore when individual's experiences are analysed, interpreted and the findings are presented. The knowledge created then is fed back again to assist individuals in their meaning-making. However, Richardson (1999, p. 65) notes that Marton and Booth rejected

both individual constructivism (individuals' active role in knowledge creation) and social constructivism (knowledge creation influenced by cultural practices, language and other people) and instead, they put forward the position that conceptions of reality were aspects of an individual's awareness and could be brought to a "reflected" or "thematized" state through the researcher's interventions during the course of an interview. Thus the key epistemological assumption of phenomenography is that "humans differ as to how the world is experienced, but these differences can be described, communicated and understood by others [researchers]" (Sjöström & Dahlgren, 2002, p. 340).

Emphasis on description is a key characteristic as it is seen as a way to access others' ways of thinking or experiencing and the focus is on the generality of thinking which is empirically explored (Svensson, 1997, p. 167). Barnard et al. (1999, p. 219) asserts that "conceptions determine our judgment, direct our inquiry, and are the explanations for our everyday lives and practices. To be aware of conceptions is to be aware of our social reality and ourselves". As in phenomenological intentionality, this thinking of people is dependent upon, and directed towards, the world or reality (Svensson, 1997, p. 165). Furthermore, the thinking is a collection of relational entities forming units or wholes suggesting a structure of meaning, and knowledge is based on the differentiation of these units or wholes (Svensson, 1997, p. 166).

In the context of this thesis, participant researchers' meaning-making and knowledge development still has the individual constructivist epistemological relevance as in the meaning-making activity of the individual mind. However, to make the epistemological contribution required to fill the knowledge gap for this research by bringing together the collections of such meaning-making and the variations among them, phenomenographic approach is a good fit. As studies about experienced researchers, especially about their technology use are very limited, a more macro level generic holistic picture generated by phenomenography is more appropriate than focusing on more micro level and individual cases using, for example, a phenomenological approach.

Many authors have compared phenomenology with phenomenography (Ashworth & Greasley, 2009; Barnard et al., 1999; Cibangu & Hepworth, 2016; Hasselgren & Beach,

1997; Marton, 1981; Marton & Booth, 1997). Phenomenography as a research specialisation has human experience as its object rather than human behaviour, mental states or nervous system (Marton & Booth, 1997, p. 116). In terms of research aims, a psychologist would focus on learning about the act of technology use; a phenomenologist would focus on the essence of technology use experience; and a phenomenographer would focus on variations in the experience of technology use (Marton, 1981, p. 180).

Another important aspect to consider is the relational, second-order, content-focus nature of phenomenography in relation to wider phenomenological approaches. Although it draws on Brentano's intentionality, phenomenography could appear as somewhat contradicting the relational nature by separating experience from the object of experience, and focusing on a second-order perspective of participants' description of their experiences (Barnard et al., 1999, p. 214; Marton, 1981, pp. 180–181). Its emphasis is on how things appear to people in their world, the way they explain it to themselves and others, and how these explanations change (Barnard et al., 1999, p. 214). In a first-order perspective, the statements are about what things are like (Marton, 2014, p. 167) or the researcher is interested in how something really is (Sjöström & Dahlgren, 2002, p. 340), and the analysis focuses on the phenomena (Prosser, Martin, Trigwell, Ramsden, & Lueckenhausen, 2005, p. 151). In a second-order perspective, statements are about what things appear to be (to someone) (Marton, 2014, p. 167) or researcher's interest is on how phenomena are conceived of (Sjöström & Dahlgren, 2002, p. 340) and the analysis focuses on the subjective experience of phenomena of those being interviewed (Prosser et al., 2005, p. 151).

In relation to the practical aspect of my study, applying phenomenological principles had some particular challenges. Since I am not part of the population, access to observe these generally extremely busy experienced researchers was unrealistic. Hence rather than use a first-order approach, such as observation of their technology use, a second-order approach was adopted. That is, the research participants in my study are oriented toward the world they are experiencing (first-order) and I, as the researcher, am oriented towards the various ways in which their world (second-order) is experienced (Marton, 1981, p. 178; Marton & Booth, 1997, p. 120). As I have experience of technology use in various contexts

I could make statements about this which would count as my first-order experience. However, in line with phenomenological approaches and demonstrating reflexivity, I tried to bracket this as much as possible in an "attempt to avoid prejudging data" (Hallett, 2014, p. 213). Essentially, my study was a process of reflection on others' experience rather than my own experience (Marton & Booth, 1997, p. 120). However, the findings involve my first-order interpretation of the second-order experience of the participants as a collective.

Criticisms and defences

Phenomenography, as a research orientation, was not well understood from early days even by those who use it and has been subject to fierce criticism to the extent that the first edited book '*Phenomenography*' in 2000 had to start its very first chapter with a defence:

> Critics of phenomenographic research allude to its perceived lack of validity, its lack of predictive power, its researcher bias and its denial of the voice of the individual through categorisation. I believe these criticisms derive from ambiguities in perspective and action evident among phenomenographers themselves, both within their own work and between different researchers. (Bowden, 2000, p. 1)

Hence phenomenography is often criticised for its lack of theoretical grounding and concealing its positivistic affiliations while claiming to be a qualitative and interpretive research approach (Webb, 1997, p. 198). An interesting point is that many of the criticisms (see Tight, 2016b, pp. 328–331) are picking on Marton's assertions in his earlier work on phenomenography (Marton, 1981, 1986). Some authors do acknowledge this as a limitation of their criticism (for example, Webb, 1997, p. 211). However, a closer examination of later works (Marton & Booth, 1997; Marton, Runesson, & Tsui, 2004) reveal that some of the criticism stems from the partial or lack of understanding about what phenomenography is and what it is not about. Phenomenography being relatively new and its clear specifications around epistemological, ontological, theoretical, and methodological issues have not been around long (Åkerlind, 2005d, p. 321). This could have contributed to the confusion. In addition, widely varied practices among phenomenographers (Åkerlind, 2005d, p. 332) have added to the ambiguity.

One of the main criticisms noted about phenomenography is around analysing individuals conceptions to develop generic categories and losing the individuals' voice in the process (see Bowden, 2000, p. 16; Prosser et al., 2005, p. 139). It is also noted as losing the essential content and context (Säljö, 1997, p. 188). That is, losing the context from utterances by taking it out of context, and putting individuals to categories. This stems from the misunderstanding of the objective of phenomenography to focus on the collective than the individual. It must be noted that meaning may vary within individuals as well as between individuals, and the whole set of data is a "snapshot of the ways of experiencing the phenomenon by a particular group of people at a particular time and in response to a particular situation" (Åkerlind, Bowden, & Green, 2005, p. 81). Analytical processes outlined later in this thesis will show that the extraction of the utterances of my participants take consideration of two contexts: one in relation to the specific transcript, and the other in relation to the whole set of transcripts (Marton, 1986, p. 43).

Converting experiences into categories is also subject to major criticism. Dependence of descriptions of conceptions (Svensson, 1997, p. 170) is seen as a liability as linguistic meanings of specific forms of language used are not primarily considered. The synonymous use of experience, understanding, etc. has been seen as problematic in terms of subjectivism especially when phenomenography rejects dualism (Hallett, 2014, p. 213). For example, what counted as participant's utterance of their experience could just be their way of talking (Säljö, 1997, p. 178), and hence the "issues of communication, language and meaning are primary in many respects when deciding on what is meant by what is said" (Säljö, 1997, p. 177). This is a very relevant point and related to the level of objectivity a researcher should have. To address this, similar to other qualitative approaches, high degree of reflexivity is expected from phenomenographers. I have embedded this in my thesis in terms of demonstrating my awareness of the context and the limitations of my subjective interpretations of the findings. There are also criticisms of objectivity in data generation (Alsop & Tompsett, 2006, p. 257) and the hierarchically structured nature of outcome space (Alsop & Tompsett, 2006, p. 244). Such validity and reliability issues are addressed later in this chapter. The key point is that phenomenographic approach focuses on the individual as well as collective context during data generation and analysis;

however, the interpretation and presentation of the findings are indeed the interpretation of the researcher.

In defence, to justify the use of phenomenography for this study, some of its benefits have already been identified in the earlier discussion. In summary, it provides an analytical approach to understand the collective experiences of a group of people in terms of the varied meanings they ascribe to a particular phenomenon, and the structure of those meanings by highlighting the critical aspects that are in their focal awareness, and relations between those key aspects within a group of individuals (Marton & Booth, 1997). It can raise awareness of the fact that people experience different aspects of the world in qualitatively different ways, and such understanding of other ways of seeing could lead to developing their own different ways of seeing the world (Dall'Alba, 2000, p. 98) and possibly even qualitatively more complete ones (2000, p. 99). In addition, it "may help uncover conditions that facilitate the transition from one way of thinking to a qualitatively 'better' [i.e. more complete] perception of reality" (Marton, 1986, p. 33). Thus, awareness of others ways of understanding a phenomenon, and its critical aspects and variations could lead to new and developed ways of understanding. This has been theorised as "powerful ways of acting spring from powerful ways of seeing" (Marton et al., 2004, p. 5).

Theoretical framework

To guide the analysis of my study and explain its findings two different understandings of experiences in phenomenographic orientation were brought together: 1) experience as subject-object relationship; and 2) experience as awareness structure. That is, phenomenography considers experience as a subject-object relational meaning, which varies based on the awareness structure of the subject in terms of their ability to simultaneously discern multiple critical aspects of the object. This is explained in the sections below.

Figure 4 illustrates development of the two understandings and its connections in two separate rows. In the first row, in terms of subject-object relationship of experiences, phenomenography draws on various psychological theories and applies a phenomenological framework. Piagetian psychology has inspired the development of

phenomenography (Marton, 1981, p. 181). Piaget is known for describing children's qualitatively different conceptions of various aspects of their reality using a second-order perspective (Marton, 1981, p. 191). However, he considered the similarities between various aspects as psychological real entities which makes 'the theme' as research object rather than 'the world'; this led to a shift from second-order to the first-order perspective (Marton, 1981, p. 191). However, Marton and Booth (1997) maintained the phenomenographic position at the second-order perspective, describing people's experiences of the world.

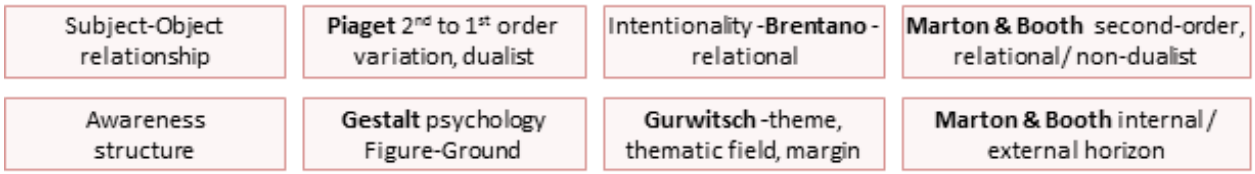

Figure 4: Two different understandings of experience

Another point is that the differentiation between subject and object was fundamental in Piaget's psychology (Marton, 1981, p. 191) whereas Marton and Booth (1997, p. 84), alluding to a non-dualist position, see experience as a relationship between subject and object. Drawing on Brentano's theory of intentionality (Morrison, 1970) and also inspired by Pramling's thesis (1983), Marton and Booth (1997, p. 85) developed the notions of 'what' (meaning) and 'how' (act) aspects of an experience. That is, in an experience, there is a direct object that is experienced (what aspect) and an act of experiencing (how aspect). As Figure 5 shows, they explain that the 'how' aspect has "its own aspects of how and what, the former referring to the experience of the way in which the act … is carried out" … and the "latter referring to the type of capabilities to master" the act which they refer as the indirect object of the act. It should be noted that each of these what and how aspects can be further divided into their own Whats (referential aspect) and Hows (structural aspect) however, it is not covered in the scope of this thesis.

Marton and Booth propose the 'what' to be the referential aspect alluding to a particular meaning ascribed to the object/phenomenon experienced by the subject (an individual), and the 'how' to be the structural aspects with both external and internal horizons (Barnard

et al., 1999, p. 216) which is a combination of features of the object/phenomenon discerned and focused on by the subject (the same individual). This can be understood by examining the relationship from subject's and object's point of view as illustrated in the figure below.

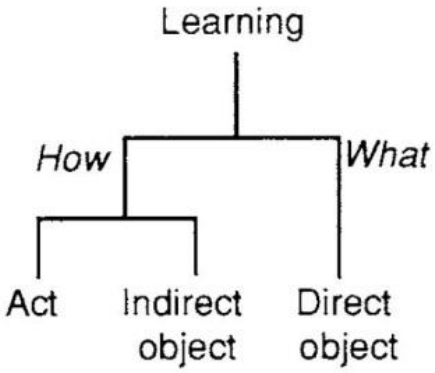

Figure 5: What and how aspects, and act, indirect and direct object (Marton & Booth, 1997)

As Figure 6 shows from a subject's (my participant researcher) point of view an object (a phenomenon, in my study, the use of technology) is a structured complex of all the different ways in which it can be experienced, and at a given point of time subject would ascribe a particular meaning to that object (referential or 'what' aspect). From an object's point of view the subject (participant researcher) is always aware of everything, although the way in which they are aware of everything is contextually variable (Marton, 2000, p. 115). This suggests a structural or 'how' aspect of the experience in terms of the combination of features discerned from the object.

Subject's view	OBJECT = structured complex of all the different ways in which it can be experienced	referential (what) - particular meaning of an individual object
Object's view	we are always aware of everything, although the way in which we are aware of everything is situationally variable	structural (how) - combination of features discerned and focused

Figure 6: Contrasting views of Subject and Object

Focussing back on Figure 4, the second row refers to awareness structure. Marton and Booth (1997, p. 123) argue that "we are aware of everything at the same time, albeit not in the same way". This awareness aspect of phenomenography is layered – a concept it draws on from the fundamentals of Gestalt psychology, in particular the figure-ground concept (Larsson & Holmström, 2007, p. 62; Linder & Marshall, 2003, p. 273; Pang, 2003,

p. 150; Yoshimi & Vinson, 2015, p. 118). Certain figural, thematised things come to the fore while other tacit and unthematised things recede to the ground (Trigwell & Prosser, 1997, p. 243). This was extended further using the 'structure of awareness' which originates in the works of the phenomenological philosopher Aron Gurwitsch (Booth, 1997, p. 141) around the field of consciousness. Gurwitsch (1964) suggested a consciousness structure of theme, thematic field and margin based on the relevance of experience. The *thematic field* may be defined as a *domain of relevancy* comprising all aspects (1964, p. 341). Relevancy implies a point of reference, that is, the *theme* (1964, p. 342). Aspects of irrelevancy to both the theme and the thematic field are referred as *Margin* as a *domain of irrelevancy* (1964, p. 344).

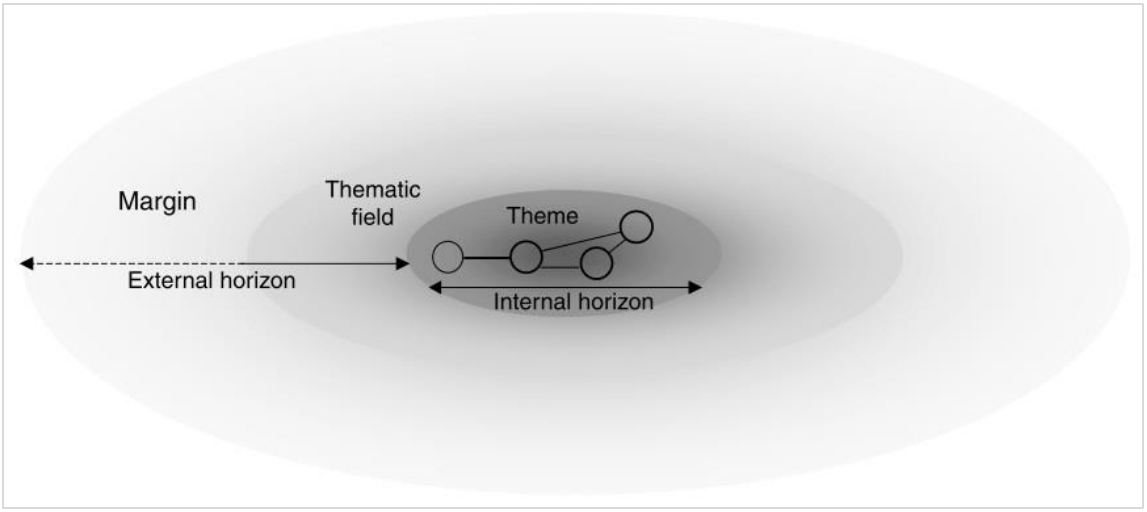

Figure 7: Gurwitsch's Structure of awareness from Cope and Prosser, 2005

Marton and Booth, however, combine thematic field and the margin as *external horizon* or the context (Marton, 2000, p. 114) from which the theme or the *internal horizon* can be discerned - see Figure 7 from Cope and Prosser (2005, p. 349). In some sense we can see that this is going back to the figure-ground (internal-external) notion in Gestalt psychology. They propose that the "different ways of experiencing a phenomenon reflect different combinations of the aspects that we are focally aware of at a particular point in time" (Marton & Booth, 1997, p. 126).

In essence, from a second-order perspective, phenomenography seeks to describe the qualitatively different ways people experience the world as categories of description or

meanings; and the relationship between those categories are understood using the structure of each category in terms of the dimensions of variations or critical aspects of the phenomenon. The structure constitutes of the theme or internal horizon (critical aspects currently focused by the subject) as well as the external horizon (other critical aspects that is not currently in focus). A way of experiencing a phenomenon could be seen as combination of its aspects (dimensions of variation) being both discerned and presented in focal awareness simultaneously. The differences in experiencing could mean that "some aspects are focused on and others [are] not, or that they are seen in a succession rather than simultaneously" (Marton & Booth, 1997, p. 136).

Building on this, variation theory suggests that to discern an aspect of a phenomena one must experience its variation (Marton & Booth, 1997, p. 134). Then, from a developmental perspective it is argued that "powerful ways of acting spring from powerful ways of seeing" (Marton et al., 2004, p. 5). Applying variation theory on the phenomenographic research outcome of structure and meaning provides insight into different ways of experiencing which in turn contributes to new understanding of the phenomena.

In this thesis, understanding the variations in meanings of technology use and the structure of those meanings among researchers, will enable me to develop a new understanding of the varied ways in which technology use is experienced among researchers. In essence, the fundamental notion underpinning the methodology for this research is that experience can be seen as a subject-object relational meaning which varies based on the awareness structure of the subject in terms of their ability to simultaneously discern multiple critical aspects of the phenomenon. The application of this theoretical framework is discussed in Chapter 7.

Research design

Phenomenographic research design involves the standard research stages of planning, data collection, analysis and interpretation (Bowden, 2000, p. 7). In practice phenomenography can be applied in different ways. Marton identifies three lines of phenomenographic inquiries that focus on 1) general aspects of learning; 2) concepts within a subject domain; and 3) pure phenomenographic interest on people's aspect of

reality in their everyday life and outside formal study settings (Marton, 1986, pp. 37–38). Within the lines of inquiries one and two, if the aim is to improve or change participants' understandings of an object of their formal studies, then it can be classed as developmental phenomenography (Bowden, 2000, p. 3). There are also variations in the modes of doing phenomenography such as Experimental, Discursive, Naturalistic, Hermeneutic, and Phenomenological (Hasselgren & Beach, 1997, pp. 195–199). Among this, Naturalistic Phenomenography "is about recording what is actually said or happens in a given situation without direct manipulation or involvement from the researcher" and then analysing it (Hasselgren & Beach, 1997, pp. 197–198).

My approach takes the third line of inquiry because, although my research happens in an educational setting, the use of technology (phenomenon or aspect of reality being described) has not been the object of formal studies. Also, it is applying phenomenographical analysis on what is actually said in the situation and there is secondary intention to effect change by enabling researchers to expose themselves to various conceptions of technology use as part of the wider researcher development agenda. Thus, considering the line, mode and developmental interest, my approach here is closer to a third line naturalistic developmental phenomenography.

Research setting and sampling

This thesis is about a topic in and from a sociology setting at a time where academic colleagues, in addition to teaching, also had an increasing responsibility for research outputs due to the REF (2014). The literature review showed that researchers were an understudied population, especially on their technology use. Selecting a theoretical sample of participants in order to maximize the variation in critical respects (Marton & Booth, 1997, p. 134) was not practical. Instead, the sampling was done within the population of experienced researchers from eight Higher Education and two Further Education institutions from England. This cross institutional sampling has improved the representativeness and taken it beyond a single institution case study. The sample included both male and female participants who had used some form of technology in their research. Some of the participants were known to me personally and I used some

elements of snowball sampling (Denscombe, 2007), especially in the first stage of data generation. However, it was ensured that “the selection of participants … [avoided] presuppositions about the nature of the phenomenon or the nature of conceptions held by particular 'types' of individuals while observing common-sense precautions about maintaining 'variety' of experience” (Ashworth & Lucas, 2000, p. 300). In line with ‘criterion sampling’, they were “individuals who have experienced the phenomenon being explored and [could] articulate their conscious experiences” (Creswell, 1998, p. 111). Such descriptions of experiences align with the second-order qualitative research approach of phenomenography that focuses on reflective meaning (Barnard & Gerber, 1999). Overall, in accordance with qualitative approaches, purposive non-probability sampling was employed (Denscombe, 2007) as I had a notion of the likeliness of my participants producing insightful data while representing the population I had scoped (sampling frame).

The sample varied in terms of their length of experience. Based on their interview and profile at the time of data generation, I have also identified their position in the ‘Seven Ages of Research’ model. The aim when constructing the sample was to maximise the range of perspectives encountered (Bowden, 2000, p. 9) and variation (Åkerlind, 2005d; Ashwin, 2006) was sought than representativeness of all research ages (for example, there were no participants from research age 3). It was ensured that the “sample selected for the study [was] appropriate and relevant to the central research question under investigation” (Collier-Reed et al., 2009, p. 347). See appendices 1a & b for a list of my participants along with their research area and research age.

The participant characteristics such as gender, and age category were included in the interview schedule (see Appendix 2a). However, during the initial interviews it became apparent that human age had no relevance in the conversation and ‘research age’ was a better measure for understanding researchers’ experience. Hence the age categories were ignored although gender was noted purely for statistical reasons to ensure a balance. There could have been questions of other characteristics such as ethnicity. However, a simple test of reading an anonymised transcript made it absolutely clear that one cannot tell the age, gender, ethnicity, etc. when they talk about their technology use for research

and hence it was decided to be not relevant for this research. This was also the case in some other studies that used phenomenography (Ashwin, 2006, p. 661).

Ethics and Power relations

Research ethical issues were considered and complied in accordance to BERA (2011) guidelines. Voluntary Informed Consent (2011, p. 5) was secured from all participants prior to the interview after explaining the context and purpose of the data generation (2011, p. 6). Necessary steps were taken to ensure that all participants understood the process, relevance of their participation and engagement, including why their participation is necessary, how it would be used and how and to whom it would be reported (BERA, 2011, p. 5). They were also free to withdraw from participating in the research at any stage. Only one such incident occurred however, since it was prior to the interview I was able to source and recruit another participant. Prior to the actual interview, I sought the permission to record, and they were assured anonymity. (See interview schedules in Appendices 2a and b). It was confirmed that the interviewee could choose to stop recording or withdraw completely from the interview at any stage (2011, p. 6).

For ethical reasons, to preserve the anonymity of participants and their institutions, pseudonyms were used and locations were disguised in an attempt to prevent recognition of identities (Sin, 2010, p. 311). At the same time, it was noted that none of the participants wanted to be identified in the publication of the research either (2011, p. 7). All interviews were recorded using a digital recorder which were directly saved to mp3 audio files which was then easy to copy to a computer. This meant I saved a lot of time in processing the recordings to a manageable format. All interviews were saved in a secure location and named in an anonymised way in accordance with the Data Protection Act (1998). Since I had conducted 26 interviews, I used pseudonyms starting from A to Z. A reference file matching the recordings to the actual participant was saved elsewhere and was password protected. All interviews were transcribed and saved in an anonymised form. In addition, when transcribing and analysing data, any details that are not critical to my research but which might help to identify the participant, were ethically omitted from reporting. For example, if the person was saying they visited or interviewed students from a particular

country or specific location it was just referred as international as the specific location was not of relevance to the research. According to the BERA guidelines, responsibilities to the Community of Educational Researchers, Educational Professionals, Policy Makers and the General Public were also ensured (BERA, 2011, pp. 9–10). Relevant anonymised extracts are only being made available to the research community and public as part of this thesis and any direct publication from it.

No children, vulnerable young people and vulnerable adults where involved in this research, and sensitive ethical issues such as age, culture, race, gender, sexuality, socio-economic standing or religion did not arise (BERA, 2011, p. 6) as they were not considered relevant to the scope of this study. This research did not target specific people because of their power however, for the sample to be actually representative, it was taken from a known wider population of experienced researchers (Walford, 2012, p. 116). No incentives were offered or provided to any of the participants (BERA, 2011, p. 7). As an outsider, I did not know too much about their world as I did not have the lived experiences as an experienced researcher. However, participants might have felt confident talking about their experiences more openly rather than trying to say what I want to hear without any interviewer power issues by not being above them but just a 'harmless outsider' (Walford, 2012, p. 112). Nevertheless, I acknowledge that my interpretations are influenced by my perspectives of working with them in various forms. I was aware of the potential power relationship issues and ensured that it did not limit the openness required "to obtain rich, meaningful data from which credible categories of description can be constituted during analysis" (Collier-Reed et al., 2009, p. 347). Through my dual roles of technology advisor and research student, I did have other connections and commitments with my participants. Care was taken to limit any effect from such relations on the data generated and its interpretations. I was aware of a small risk of experienced researchers thinking that my findings could be stigmatic or expose an area of development they may not prefer and hence affect their responses during data collection. However, participants were encouraged to raise and discuss all such concerns as I thought that it could lead to highlighting some underlying factors that influence their use of technology.

Interview Method

Phenomenography does not concern itself with data triangulation and uses interview as its primary means of data generation (Green, 2005, p. 36). However, any form of data that in some way serves as an expression of the ways in which people experience some part of their worlds, such as published documents or artefacts, can also be used as data. Phenomenography is predominantly methodological and has emphasis on its empirical details which are outlined below.

The interview can be seen as the relationship between interviewer and interviewee in bringing the interviewee to a state of meta-awareness (Marton & Booth, 1997, p. 132). The data generation was driven by the research questions outlined earlier. Interviews are suitable if we assume that conceptions are most accessible through language (Svensson, 1997, p. 166) however, "one should be extremely cautious of considering this as indicating a way of experiencing rather than as, for instance, a way of talking" (Säljö, 1997, p. 178). Ashwin reminds us of phenomenographers' argument that we only have access to what people communicate or do and, their utterance are accounts of experiences rather than conceptions (Ashwin, 2006, p. 655). In addition to experience, phenomenographic interview will also capture variation in intuition, insight and ways of thinking (Hallett, 2014, p. 211). In essence, each participant statement represents one of the ways they experience the phenomena at that moment and in that context.

Marton and Booth (1997) point to the two levels of interview: an interpersonal contact resembling a social discourse; and a meta-level like therapeutic discourse with reflections. The latter can be problematic and the researcher could face resistance from interviewees. Hence, during interview, alternative questions or interpretations of things the interviewee had said earlier could be used to bringing them repeatedly back to the focus for reflection. This has similarities with psychotherapeutic handling of transference through self-awareness and positioning, and it should be expected that the interviewee might reject such interpretations (Marton & Booth, 1997, p. 130). For my study, the interview questions were developed with this in mind and some were open questions and others were encouraging them to reflect on or challenge various interpretations (see appendices 2a and

b). All interviewees reacted well and actively engaged with this approach however, as Marton and Booth (1997) warn, one interviewee felt uncomfortable with such interpretations and became slightly defensive and resistant to the rest of the interview, resulting in a shorter interview. Nevertheless, overall, this approach was very fruitful in generating useful insights.

Phenomenographic interviews are exploratory but should have a focus on the conceptions of objects or phenomena, as well as the interviewees' delimitations and experienced meanings (Svensson, 1997, p. 169). The challenge for the researcher is to understand and interpret what the respondent is trying to convey, and decide about further questioning or probing to avoid any misunderstanding that could jeopardize the quality of data (Sjöström & Dahlgren, 2002, p. 341). To this effect I had indicative interview questions in a semi-structured guide. I had started with some introductory questions (Kvale, 2007, p. 60) and the subsequent dialogue were according to the answers obtained (Sjöström & Dahlgren, 2002, p. 341). Not all of the questions in the set were asked in every interview to allow opportunistic questioning and respondent elaboration (Marton & Pong, 2005, p. 337). Some of the questions were direct and short, while others were indirect and long. I personally found that such a range and mix of questions were helpful in getting the participants engaged in the interview and elicit different types of accounts. As a researcher I did not try to assess the answers as being right or wrong but showed a real and honest interest in getting the participant to express themselves as clearly and thoroughly as possible (Sjöström & Dahlgren, 2002, p. 341). Such open-ended questions allowed the interviewees to decide on those aspects of the question most relevant to them (Marton, 1986, p. 42) and at the same time they were also "designed to be diagnostic, to reveal the different ways of understanding the phenomenon within that context" (Bowden, 2000, p. 8).

Typically, phenomenographic studies ask the participants to do a task and reflect. This helps to elevate participants to a state of meta-awareness which is central to data collection strategy (Collier-Reed & Ingerman, 2013, p. 248; Marton & Booth, 1997, p. 130; Reed, 2006, p. 5). A similar approach was employed in this study. In the first round of data generation the phenomenon (technology use) was "anchored in the interview situation", whereas in the second round tasks based on early findings from first round were used to

"transcend the situation" (Marton & Booth, 1997, p. 130). The aim was to bring interviewees' technology use experience to the fore by asking them to complete a task to identify the technologies they are likely to use for research, other activities, or both (see appendix 2b: section 1). It was followed by asking them to reflect on any differences between technology use for research activities and teaching and learning. This was based on the advice to work "together with the interviewee to bring forth [their] awareness of undertaking the task, a state of meta-awareness" (Marton & Booth, 1997, p. 130). Such activities also made the interview more interesting and engaging than mere questions and answers (see appendix 2b: section 1 – 3).

During the interview, the questions seemed to generate relevant conversation and hence there was no need to amend the interview schedules at any stage. On reflection, some participants did not necessarily fully understand the some of the questions but answered them anyway, while some others had asked for clarifications. Phenomenography was useful in this context as its analytical approach encourages selecting all relevant utterances to be treated equally. Hence I let them continue as it eventually revealed what that question meant for them. However, in cases where the response did not link to my research questions, I had to probe further to bring back the focus. This ensured that I got their understanding of the question as well as the relevant responses needed to answer my research questions.

Data generation and management

The data generation through interviews were done in the first round over a period of 6 months (Mar-2013 - Oct-2013) with 26 participants from 10 institutions across England. Some of the positivistic nature of questions helped to profile the participants' characteristics and provided a descriptive overview of the sample. The aim was to capture the similarities and variations in the contexts among the population which would highlight what informs their technology use. It was also important to understand researchers' key activities to inform how researchers see technology helping them in those activities and explain any relationships between use of technology and such activities.

After a set number of interviews, the responses and evidences started to become repetitive. After 26 interviews it was felt that sufficient depth and range of the phenomenon was achieved (Baker & Edwards, 2012, p. 37) leading to data saturation. It was also in line with how phenomenographic literature discusses, and its 'epistemic community' views and evaluates (Baker & Edwards, 2012, p. 25) the required amount of data. In this case it was decided that the required variation for the phenomenographic approach was achieved.

Phenomenographic studies do not often do multi-rounds of interviews (Åkerlind et al., 2005, p. 76) as the findings go beyond the individual voices (Green, 2005, p. 40) although there are exceptions, for example, when the research is designed to investigate change in understanding (Prosser et al., 2005, p. 140). I wanted to explore some of the issues deeper and focus on wider conceptions from a different angle. Technology changes very fast and new developments are becoming available to researchers. Follow up interviews were necessary to supplement the initial shorter interviews with some specific themes to engage interviewees in a more focused meta-awareness (Marton & Booth, 1997, p. 129) based on themes that were common from the first interview. So, a year after the first round of interviews, the second round was conducted over a period of 4 months (Oct-2014 - Jan-2015). I used the same pool of participants from the first round, and selected a mix of 13 male and female participants from 6 different intuitions who seemed to show an interest in discussing issues from their own experience as well as of the wider population.

In line with my research approach, the questions of this second round were designed as a discussion of wider issues in the field through exploring individual's experiences. It was envisaged that these discussions would go beyond the individuals and highlight various experiences and conceptions that are present within the wider population. The questions were also expected to encourage participants to reflect on their experience of the phenomenon in relation to them as well as their peers' perceptions and experiences.

I also considered this as an opportunity to evaluate or validate some of the initial findings. However, phenomenography advises against getting feedback from the interviewees as it focuses on the collective rather than the individual, and each transcript is only interpreted in comparison with the rest of the transcripts making 'member checking' inappropriate as a

validity check (Åkerlind et al., 2005, p. 81). It is possible to include interviewees as members of a focus group to test the "categories as encompassing their range of perspectives" (Bowden, 2005, p. 30). For round two, ensuring a spread of research areas among researchers, I had selected half of the initial sample based on their availability. The aim was to have a longer discussion on verifying my initial interpretations rather than the responses of any particular individual. That is, I was not asking to verify their own perceptions but how far my initial interpretations were plausible. In that sense I am using the interviewees in round two as "members of the population represented by the interview sample, and the intended audience for the findings" (Åkerlind, 2005d, p. 330).

Seeking critical reflection was also part of the second round of data generation where participants were asked to comment on the key themes from the first round of data as well as existing literature. Since the participants were also researchers themselves I made an assumption that they would understand what I meant when I asked them to critically reflect on some of the emerging themes. This did not always work as smoothly as I had envisaged as some participants did not want to critically examine their technology use for research. However, where it worked, it acted as a 'peer debriefing' type of internal validation (Lincoln & Guba, 1985, p. 301) to see whether it represents the responses of the population.

Data generated through the two rounds of interviews were transcribed and managed in a truthful, ethical, secure, and systematic way. All interviews were transcribed as accurately as possible but not necessarily to record every tonal inflection or pause in speech as a phenomenographic analysis does not have the same focus on linguistic elements as a method such as discourse analysis (Collier-Reed et al., 2009, p. 350). See appendices 3a and b for the process followed for the transcription and data management.

Analytical framework

In line with the data generation and broader theoretical framework the key analytical approach employed was a phenomenographic analysis (PgA). It has similarity with grounded theory to the extent that themes are inducted from the data (Richardson, 1999, p. 68) and does not use *a priori* themes. Similar to phenomenological epoché (Schwartz, 2002, p. 54) researchers are also expected to bracket what they already know or have

experienced about the phenomena (Ashworth & Lucas, 1998, p. 418; Walsh, 2000, p. 30). However, to address research questions 1 and 2, a Template Analysis (TpA) was also necessary. The phenomenographic analysis was specifically for the third research question. The combined approach is explained below.

Template Analysis is a particular way of thematically analysing qualitative data and "involves development of a coding 'template', which summarises themes identified by the researcher(s) as important in a data set, and organises them in a meaningful and useful manner" (King, 2007, para.1). It emphasises a hierarchical coding where the broad themes encompass successively narrower, more specific ones. TpA could start with some *a priori* codes that identify themes strongly expected to be relevant to the analysis although this may be modified or dispensed where appropriate. TpA suggests some of the following key procedural steps (Brooks & King, 2014): familiarise with the raw data; preliminary coding (can use *a priori* themes); define initial coding template; apply and modify initial template using further data; iterative process of trying out successive versions of the template; and define final template and apply to the full data set. How this was used along with phenomenographic analysis is outlined in the analysis stages one and two.

In phenomenography, the unit of analysis is *a way of experiencing* a phenomenon and the object of the research is *variation* in ways of experiencing it (Marton & Booth, 1997, p. 111). Svensson, refering to it as contextual analysis, summarises that:

> …the main focus is on differentiating parts of the data. One differentiation concerns the delimitation of the phenomena to be described. Another differentiation concerns significant parts of the data representing fundamental whole-characteristics of the phenomena (Svensson, 1997, p. 170).

This means PgA aims to group the qualitatively similar ways of experiences into categories and then identify the critical aspects and its dimensions of variations that distinguishes various categories. In other words, researchers need to discern the internal structure and the intertwined meaning of the object of research (Marton & Booth, 1997, p. 133). The important point is that phenomenographers are not trying to describe how the interviewees understood their subject matter, but rather how they described their experience of understanding (Prosser et al., 2005, p. 140). In essence, phenomenographic analysis

identifies ways of experiencing a phenomenon and the variations in expressing them (Marton & Booth, 1997, pp. 133–134).

There are two different ways of approaching the phenomenographic data analysis: *segmenting the transcripts* (Marton & Pong, 2005, p. 337) and *treating the transcript as a whole* (Åkerlind, 2005d, pp. 323–324). Marton's (1986, p. 43) approach suggests selection of relevant utterances from all interview transcripts without losing its contextual values and putting them into a 'pool of meanings'. However, Bowden (2000, p. 11) raised concerns and argued that taking extract out of the transcripts loses its context. To avoid such risk of de-contextualisation he and team used each transcript as a whole and analysed each utterance. The 'whole of transcript' approach provides wider context for researchers to faithfully interpret the meanings of particular comments while 'pool of meanings' approach means decontextualisation favouring the phenomenographic focus on the collective than the individual meanings (Åkerlind et al., 2005, p. 92).

Marton's approach was used in my study as the focus was on the collective experience rather than the detail of individual (Åkerlind et al., 2005, p. 82), and individual's conceptions can change in different contexts and time. That is, "an individual's experience of a phenomenon is context sensitive, and so can change with changes in time and situation" (Åkerlind, 2005d, p. 331). So it will be inappropriate to label each transcript (and hence the individual) with a certain stratification or category of description. Dahlgren and Fallsberg (1991) proposed various steps for the PgA: familiarization, compilation, condensation, preliminary grouping, preliminary comparison, naming the categories, and contrastive comparison. (Also see Sjöström & Dahlgren, 2002, p. 341). However, this approach mainly focuses on forming the referential aspects or categories. Marton and Pong (2005, p. 337) extended the analysis to focus on identifying the structural aspect of each conception expressed forming the dimensions of variations. So a combination of both approaches are used for my study. Again, how this was implemented in practice, in combination with TpA, is outlined in the analysis stages below.

Analysis stage one: identifying referential aspects

Based on Marton and Pong's (2005, p. 337) two-stage analysis, "the first stage focused on identifying and describing the conceptions in terms of their overall meanings". It starts by a familiarisation process which is common to both TpA and PgA approaches. Since I was not part of the population (experienced non-STEM researchers) and their field, I felt a data familiarisation stage was a good place to start. Some phenomenographers are against starting the analysis until all interviews have been conducted to ensure consistency (Bowden, 2005, p. 19) while others either favour early analysis for the practical value and manageability of sheer amount of data generated or adopt a combined approach of completing all of the interviews and starting with a preliminary analysis on a subset of the transcripts followed by the rest of the data (Åkerlind et al., 2005, p. 91). This is where the TpA appeared useful in my study because of its flexibility to start with or without *a priori* themes; as well as the ability to apply it on a small set of data and iteratively modify or append the themes (Brooks & King, 2014). TpA of the first round of interviews helped to inform what questions to follow up in the second round.

Familiarisation process of the raw data is where the researcher is introduced to the empirical material by reading through the transcripts and correcting any errors (Sjöström & Dahlgren, 2002, p. 341). After completing all the interviews in the first round, each of them were listened again to correct any transcription errors and make additional notes. TpA can be done with a few sets of transcripts or initial set of data. Incidentally this is not uncommon in phenomenography either (see Åkerlind, 2005a, p. 174). The process involved listening and reading and then coding each of the relevant text into specific theme or themes using descriptive codes (Miles & Huberman, 1994, p. 61). This step was repeated twice for the whole data. Then the descriptive codes were reviewed to remove duplicates and merged similar ones where the key concepts were not lost. Thus the data from first round were divided into eight themes: profile, meaning, usage, experience, support, strategy, influence, and instance.

In addressing the second research question, a TpA was employed to understand the researchers' issues around technology use and this informed the themes to focus on for

the second round of interviews. Although second round of data generation is not common in phenomenography as mentioned earlier, Marton and Booth (1997, p. 129) recognise the possibility and its effect when they note that “early phases of analysis can influence later data collection”. In my case, this second round and its effects on the research are acknowledged in the data generation section of this chapter. Following from the initial round, all the interviews in the second round were also listened to and notes were made.

The next step involved preliminary coding using TpA which is equivalent to PgA approaches of segmenting, compilation, and condensation of the transcripts. Since each interview may contain elements of more than one of the categories of description (Ashwin, 2006, p. 655) the process involved “marking and segmenting the transcripts according to the themes addressed” (Marton & Pong, 2005, p. 337). In practise, answers from all participants to a certain question were compiled to identify the most significant elements. This was eventually condensed to find the central parts of longer answers or a dialogue (Sjöström & Dahlgren, 2002, p. 341). In TpA terms this is similar to preliminary coding using *a priori* themes (Brooks & King, 2014).

From this point all the interviews from both round one and two were treated as a single data set which contained material pertaining to individuals as well as to the collective (Marton & Booth, 1997, p. 133). Barnard et al. (1999, p. 216) warn against selecting statements without consideration given to an entire transcript and the intended meaning. However, Ashwin (2006, p. 655) asserts that “the outcomes from phenomenographic studies are based on the variation across all of the interview transcripts, rather than a categorisation of each individual in the study”. Hence although the attention was shifted from the individual subjects or interviews to the meanings embedded in quotes, contexts from the interview, as well as the context of the group it was brought to, were also given consideration (Marton, 1986, p. 43).

Further steps in terms of PgA were preliminary grouping or classification of similar answers; preliminary comparison to establish borders between the categories and revision of the preliminary groups; and then naming the categories to emphasize their essence (Marton, 1986, p. 43; Sjöström & Dahlgren, 2002, p. 341). At this point it was noted that a

conception may be expressed in many linguistically different ways and different conceptions may be expressed in a very similar language (Svensson, 1997, p. 170). It was also important to look for negative as well as supporting examples (Åkerlind et al., 2005, p. 89). TpA was helpful in addressing such confusions as I could form an initial template then modify it using further data through an iterative process of trying out successive versions of the template and then defining the final template to apply it to the full data set (Brooks & King, 2014). This template was used for another round of focused analysis and refined again to answer the research questions one and two. Such strongly iterative and comparative process of continual re-sorting of data (see appendix 3b for analysis workflow summary) resulted in identifying similarities and differences between the data and developing categories as well as between the categories themselves (Åkerlind, 2005d, p. 324). Finally, in line with Marton and Pong's (2005, p. 337) suggestion, "a unit [category] was formed whenever there was sufficient evidence that a particular overall meaning had been expressed".

Analysis stage two: towards structural aspects

The second stage in PgA was to understand the structural aspect of the categories by identifying "the elements of the phenomenon that were focused upon, and to devise a description of each conception's structural aspect" (Marton & Pong, 2005, p. 337). The variation was identified in two ways: the explicit variations that the participant brought in as they focused on a particular element; and the variations that were implied by that element (Marton & Pong, 2005, p. 337). The latter is my interpretation as the researcher and not necessarily intended by the participant. To an extent this is similar to using *a priori* themes and contradicts the phenomenographic premise of its affiliation to a grounded approach. However, it was useful for my research on two counts. One, at this stage, I had to focus on answering the first research question of researchers' experience of researching and two, ensure that the findings informed my PgA.

The outcome of phenomenographic research is an interpretation of the researcher or a relation between the researcher and the data. Marton and Booth asserts that:

> The researcher has a responsibility to contemplate the phenomenon, to discern its structure against the backgrounds of the situations in which it might be experienced, to distinguish its salient features, to look at it with others' eyes, and still be open to further developments (Marton & Booth, 1997, p. 129).

As Marton and Booth suggest I wanted to ensure that the experience of using technology should be interpreted in the context of their experience of doing research. I have used two researchers' experience models of Angela Brew (2001, p. 280) and Gerlese Åkerlind (2008a, p. 25) to shape the *a priori* themes (discussed in Chapter 4). TpA seemed a good approach as I could bring those two models as *a priori* themes. Although it was not intentional the four keys themes of researchers' experience of doing research also seemed to help understand the structural aspects of their technology experiences as discussed in Chapter 6. The second research question around the characteristics of technology use was also addressed at this stage, again using a TpA. The results are discussed in Chapter 5. In addition, the findings based on the second research question, especially around skills development, also contributed to understanding the structural aspects. Thus, as Marton and Pong alludes above, these were *a priori* themes equivalent to variations in technology use experiences that were implied by the elements focused by the participant. However, these were not just forced into the structural aspects but tested and confirmed to make logical sense and grounded against data. It is also important that the categories can be argued for convincingly basing on the data (Ashwin, 2006, p. 655). Hence, Chapter 6 starts with illustrating the validity of themes using relevant quotes from participants (Marton, 1986, p. 43).

The critical variations were then formed as dimensions of variations, and the relationships with categories of descriptions were mapped as a table. After various iterations, the different versions of outcome spaces were developed (see Appendix 5). These were tested with other experienced researchers and international phenomenographers to ensure that they captured the relationships between categories of descriptions and dimensions of variations. The feedback confirmed that the final outcome space (see Chapter 6) communicates this very well.

Presentation of findings and dissemination

Presentation of findings, and dissemination are key parts of all research. The most essential outcomes of phenomenographic research constitute the descriptions of differences and similarities in how the world is conceived (Sjöström & Dahlgren, 2002, p. 340). Such forms of results mean there is a favouring of abstraction, reduction and condensation in relation to the richness of the object and data (Svensson, 1997, p. 167). This makes it a challenge to present the findings in a way that readers can get a sense of researcher's interpretations based on the data without having to read through the full transcripts. To facilitate this, relevant participant quotes were formatted as below and used in the presentation of findings.

As alluded earlier, since the linguistic elements were not as critical as it would be in discourse analysis, the interview data was tidied up from unnecessary 'ums' and 'ers'. The text in square brackets such as *[ ]* indicate that I have added or edited the content and *[…]* shows that I have omitted some text that is not relevant in that particular context. The quotation includes pseudonym of the particular participant. Although some phenomenographers have used additional participant characteristics (see quotes usage in Brew, 2001, p. 276) in this case, their research area, research age, etc. were not included with the presentation of quotations as those elements were not critical in the data analysis and were unlikely to make a difference to the reader's understanding. Similarly, it was irrelevant to note whether the quotation was taken from first or second round of data generation as they were all analysed as a single set.

In terms of dissemination, the early findings were presented at international conferences, and a journal article was also published (see appendix 6).

Trustworthiness as Validity and Reliability

Ashworth and Lucas (2000, p. 296) assert that "the process by which the research is conducted is of key importance in terms of determining whether the outcomes are ontologically defensible and epistemologically valid". Issues of Objectivity, Reliability and Validity referred in quantitative research paradigm are addressed differently in qualitative

approaches such as Phenomenography with their equivalents of Confirmability, Dependability, and Credibility (Internal Validity) and Transferability (External Validity) respectively (Lincoln & Guba, 1985) and together these are referred as Trustworthiness.

Confirmability can be achieved through the audit trails that demonstrate the rigour and transparency in planning, data collection, analysis and interpretation (Åkerlind et al., 2005, p. 89). Audit trails are key for achieving Confirmability as well as Dependability. Types of such evidence include 1) raw data; 2) data reduction analysis; 3) data reconstruction and synthesis; 4) process notes; 5) intensions and dispositions; 6) instrument development (Lincoln & Guba, 1985, pp. 382–384). For this thesis, some relevant evidences from these are provided in appendices 3 and 5. Reflexivity deals with issues of researcher objectivity and is also part of Confirmability. In practice, the researchers recognise their own preconceptions, take conscious and systematic measures to limit their influence on the research process while documenting all the steps (Sin, 2010, p. 310). Evidence of such conscious effort from me is present in the reflexive reporting of this thesis demonstrating the confirmability.

In terms of phenomenographic Dependability (Reliability), research teams have an advantage over individual researchers (Åkerlind et al., 2005, p. 89). However, the large number of phenomenographic PhDs and projects are evidence that individual researchers can achieve high quality research (Åkerlind, 2005d, p. 328). Teams can apply interjudge reliability (Marton, 1986, p. 35; Sandbergh, 1997, p. 205) which can include 'coder reliability checks' where two researchers independently code and compare part or whole of interview transcripts; and 'dialogic reliability checks' for negotiating consensus in terms of mutual critique of the data and their interpretive hypotheses (Åkerlind, 2005d, p. 331). Thus interjudge reliability is also a form of replicability (Sandbergh, 1997, p. 205) although it can distract researchers from procedures for achieving faithful categories of description (1997, p. 207). Hence Sandbergh (1997, p. 211) had proposed Reliability as 'interpretative awareness' through 'phenemenological reduction' that is, holding back familiar theories and prejudices (bracketing or epoché) in order to be open to participants' conceptions under investigation (1997, pp. 209–210). This is more suitable where the research is done by a

single researcher and hence is applied in this thesis as explained under the epistemological position (see page 53) and as below.

As Åkerlind et al. (2005, p. 90) advise, a critical attitude towards interpretation has been taken and presuppositions were bracketed. During the analysis a substantial break occurred naturally due to my work commitments which happened to strengthen the analysis by acting as my own devil's advocate (2005, p. 89). This also can be equivalent to interjudge validity where I am the first and second judge separated by time. The third option was to get feedback from others (Åkerlind et al., 2005, p. 89) and peer debriefing (Lincoln & Guba, 1985, p. 301) was used to achieve this as discussed below.

Credibility (Internal Validity) in a study is understood as the extent to which it demonstrates that the study measures what it sets out to do (Collier-Reed et al., 2009, p. 342). Relevant credibility types include content-related credibility which concerns the researcher's familiarity with the subject matter under investigation; methodological validity (credibility of method) looks at how the goals of the study match its design and execution; and communicative credibility involves the researchers' ability to argue their interpretation of the data (Collier-Reed et al., 2009, p. 343).

Credibility has been applied to my study in a number of ways. In the case of this thesis I had content-related credibility as I know just enough about the field but am not an expert, allowing me to be open to other ways of understanding (Collier-Reed et al., 2009, p. 347). In terms of methodological credibility, through this chapter and other areas I am providing a full and open account of methods used to illustrate integrated verification strategies for the readers to evaluate the trustworthiness (Cope, 2004, p. 4). Communicative credibility, sometimes characterised as a measurement of the communicability (Sandbergh, 1997, p. 205), is about using approaches and interpretations regarded as appropriate by the research community and other members of the research population (participants are normally not included), and the intended audience for the findings (Åkerlind, 2005d, pp. 330–331). I had discussed my findings with multiple researchers from the groups above including phenomenographers and found the outcome space (see Chapter 6) to be communicative.

Relationship to context(s) is another essential aspect in the development of trustworthiness in phenomenographic research. This is important in the generation of empirical data, how the analysis process is conducted, and the implementation of the research outcomes. It is also related to the domain of researcher (me), the collective, and the individual participant (Collier-Reed et al., 2009, p. 344). Most of these allude to trustworthiness as it takes place within the research project or in the 'internal horizon', which is different to the context of impact of the study outside the project (for example, transferability) which is the 'external horizon' such as the implementation of the research outcomes (Collier-Reed et al., 2009, p. 339). In this thesis the 'internal horizon' of the context is clearly described and considered in the analysis stage (see analysis stages discussed earlier in this chapter) and findings chapters (4-6), and the 'external horizon' of the context is included in the discussion Chapter 7.

In essence, all credibility strategies suggested by Lincoln and Guba (1985, p. 301) are relevant to phenomenography except 'Persistent observation', as interview is the only method used; and 'Member checking', since the interpretation is done for the collective as discussed earlier (Green, 2005, pp. 44–45). Instead a peer debriefing or external check (Lincoln & Guba, 1985, p. 301) was done with the participants from the second round as well as other experienced researchers. All these credibility claims are made in relation to the data available (Marton & Booth, 1997, p. 136) by providing excerpts from the interviews (Sjöström & Dahlgren, 2002, p. 342).

The final aspect of trustworthiness is Transferability (External Validity). Transferability can have a combined responsibility of the readers being the judge of how much the findings are transferable to their setting, although external validity is solely my responsibility as the researcher (Sin, 2010, p. 309). Phenomenography rejects replicability in relation to Transferability. When and under what conditions a person is capable of experiencing a phenomenon in a particular way falls outside phenomenography proper (Marton & Booth, 1997, p. 136). It is unreasonable and undesirable to expect other researchers to find the same categories, other than to recognise in another context when explained by the researcher in detail (Marton, 1986, p. 35; Sandbergh, 1997, p. 205).

In a pragmatic way, Marton (2000, p. 134) asserted that "it is less important that my findings are seen as valid and reliable, than that they are generative of new insights". At the end of the day Phenomenography is a process of discovery and discoveries do not have to be replicable (Sjöström & Dahlgren, 2002, p. 342) and instead Pragmatic validity, the extent to which the research outcomes are providing useful insights about how the world operates (Åkerlind, 2005d, p. 331), should be the criterion. In essence, it is the rigour in the process and its explicit accounts that is presented in this chapter and others bring the trustworthiness of phenomenographic research (Åkerlind et al., 2005, p. 87). Along with audit trails (as included in the Appendix 5), Plausibility is what phenomenographic research should be judged on. Plausibility is the extent to which a new knowledge claim follows on from, or at least is not incompatible with, what is currently taken to be sound knowledge (Hammersley, 2009, p. 16), which is evident within the discussion Chapter 7. In summary, this thesis fully adheres to the phenomenographic standards of trustworthiness.

Chapter conclusion

Based on phenomenographic orientation this chapter outlined the conceptual, theoretical, and analytical frameworks employed in this study. Using a critical commentary grounded in supporting literature, it has outlined the design, implementation and evaluation approaches employed in this study. Here the research methodology is based on the notion that experience can be seen as a subject-object relational meaning which varies based on the awareness structure of the subject in terms of their ability to simultaneously discern multiple critical aspects of the phenomenon. The meaning and structure can be understood using a phenomenographic analysis of description of people's thinking about their world as a collective. The outcome would be researcher's (my) interpretation of the second order perspectives of the participants.

The next three chapters outline the findings based on the three research questions under the themes, researchers and researching, researchers and technology use, and varied experiences of using technology.

Chapter 4: Researchers and researching

Introduction

> *[Researching… it is] very stimulating to have chance to reflect on deeper ideas… in a way that you probably can't in other sort of careers. (Isabel)*

The thesis aimed to understand experienced non-STEM researchers' use of technology. The methodological approach for this study adopted a phenomenographic orientation to analyse the collective experience of the participants. Addressing the first research question this chapter analyses researchers' experiences of doing research. This chapter makes two key contributions. One, it identifies some key aspects of how researchers experience research and highlights some of the pressures on them from related academic and non-academic activities. This in turn triggers a search for enablers to secure efficiency gains and leads to considering use of technology as one of the avenues. Two, this chapter also contributes to Chapter 6 in terms of how critical aspects of experiences of doing research informs researchers' experience of using technology.

Since technology is now part of everyday life and other activities in professional roles distinguishing experiences of doing research and related issues will inform how this contributes to their technology use. From the review of literature (see Chapter 2) it is evident that there are lesser studies about researchers and researching than other academic activities in further and higher education contexts. In addition, there are very limited studies about experienced researchers compared to PGRs and early career researchers. My thesis examined researchers' experience of doing research particularly from a technology use point of view, so it was important to understand their research experiences and activities first. The participants of my study were experienced educational researchers from 10 different institutions and were interested in a range of research areas (see Appendix 1a). This chapter examines their research experience, and links it to their technology use. It starts with two main themes: research as an intellectual experience; and research as a process-based experience. It also examines researchers' emotional experiences, and some issues pertinent to their background such as varied roles, workloads, and its effect on research; pressure from the business and funding aspects of

research; and their work environment. The chapter ends by discussing the axioms of technology as an enabler of research as a prelude to Chapter 5.

As part of the data collection in order to understand researchers' technology use participants were asked about their research and the process of researching. This was to examine the context and their experiences of conducting research. From the data it appeared that researchers used technology predominantly for process-based tasks compared to intellectual thinking tasks which they mostly preferred to do themselves, and often did at non-official spaces such as home. To understand their experiences of technology use, it is necessary to understand their experiences as a researcher in general. Participants' conceptions of research were examined using existing conceptual frameworks and a template analysis was used to examine these contextual understandings. The analysis, based on literature around researchers' conceptions and experiences, has led to two key aspects of researchers' experience: research as an intellectual experience; and research as a process-based experience. The next section critically introduces two relevant models to illuminate the data, and then uses template analysis (Brooks & King, 2014; King, 2007) to apply them in examining researchers' experiences using related literature and participant quotations.

Models of research conceptions

My findings have been interpreted using Angela Brew's framework (Brew, 2001, p. 280). Her study is similar to mine however, she identifies the variation in conceptions of 'research' among senior academic researchers, and from a range of disciplines while mine has focused specifically on non-STEM researchers and their use of technology. Her framework provides an intellectual lens to understand researchers' experiences (Model A in Table 2).

She has divided the research conceptions based on what elements are in the foreground, and how it is interpreted for research. Based on these dimensions four categories of conceptions are identified: Domino, Layer, Trading, and Journey. The strength of these conceptions lies in having the varied intellectual aspects in their foreground. For example, the 'Domino conception' sees research as a linear list of separate elements that are linked

together, and they are synthesised to address the research problem. In 'Layer conception' it is about recognising that the research data contains ideas with hidden layers of meanings to be uncovered. The 'Trading conception' however, focuses on researchers gaining recognition and reward through exchange of research outcomes at a social (academic) market place. Finally, the 'Journey conception' brings the personal touch by focusing on the researcher's existential issues experienced throughout their career and transformation. However, it lacks the process elements of how the research is conducted, and the challenges and struggles involved in doing so. Nevertheless, its intellectual aspects are used here to examine and understand researcher experiences using quotations from my research participants.

	Structural dimension (what is perceived and how the elements of what is perceived are related to each other) What is in the foreground is/are:	Referential dimension (the meaning given to what is perceived) Research is interpreted as:
Domino conception	sets (lists) of atomistic things: techniques, problems etc. These separate elements are viewed as linking together in a linear fashion;	a process of synthesising separate elements so that problems are solved, questions answered or opened up;
Layer conception	data containing ideas together with (linked to) hidden meanings;	a process of discovering, uncovering or creating underlying meanings;
Trading conception	products, end points, publications, grants and social networks. These are linked together in relationships of personal recognition and reward;	a kind of social market place where the exchange of products takes place;
Journey conception	the personal existential issues and dilemmas. They are linked through an awareness of the career of the researcher and viewed as having been explored for a long time.	a personal journey of discovery, possibly leading to transformation.

Table 2: Model A: Structural and referential dimensions of conceptions of research (Brew, 2001)

Brew's conceptions above can be further expanded using Gerlese Åkerlind's (2008a, p. 25) model of ways of experiencing research. It brings what Brew's model is lacking – the effort and struggle of researching (Model B in Table 3). In other words, it recognises the process-based elements of realising a research. Åkerlind's model provides a contrast to Brew's model, and helps to examine my research participants' experiences from a process-based perspective.

Åkerlind has explored academics' ways of understanding research and noted the emphasis in literature around the 'what', 'why', 'how', 'outcome', and 'feelings' of doing research. In

terms of categories of conceptions she addresses 4 purposes that are focused by researchers: 1 Fulfilling requirements, 2 Establishing oneself, 3 Developing personally, and 4 Enabling change. It then addresses each of these against the research intentions, questions, processes, outcomes, object of study and added the element of researchers' feelings. This model provides a better focus on the process-based research experiences than just intellectual activities as in Brew's model. It is used here to examine and understand researchers' process-based experiences through its categories that highlight the effort and struggle of researching. Quotations from my research participants are also used to present the process-based nature of research.

	Categories			
Dimensions	1 Fulfilling requirements	2 Establishing oneself	3 Developing personally	4 Enabling change
Researcher intentions	Fulfil academic role	Become well-known	Solve a puzzle	Make a contribution
Research process	Identify and solve a problem	Discover something new	Investigate an interesting question	Address community issues
Anticipated outcomes	Concrete products	Academic standing	Personal understanding	Benefits to community
Object of study	Independent research questions, bounded by a field of study	Integrated research questions, related to a field of study	Integrated research questions, related to field and personal issues	Integrated research questions, related to field/social issues
Underlying feelings	Anxiety to satisfaction	Frustration to joy	Interest and enthusiasm	Passionate engagement

Table 3: Model B: Key aspects of variation in ways of experiencing being a university researcher (Åkerlind, 2008a)

Brew's and Åkerlind's models are useful in explaining the intellectual and process-based aspects. Both models have been used in studies individually and together (Kiley & Mullins, 2005; Stubb et al., 2014). They both, however, have limited use in understanding the drivers of the conceptions or experiences. Neither are they useful in understanding the institutional, political, and policy related pressures and challenges my participants were facing. In other words, these two models are far from the frontline realities faced by the researchers. However, structurally, this chapter starts with the higher level conceptions, process-based experiences, and later addresses some of the real world challenges of my participants as well.

There are other ways that the data could be conceptualised drawing on other models. For example, Pitcher and Åkerlind (2009, p. 167) identify conceptions of research such as 'explorative', 'spatial', 'constructive' and 'organic'. However, these are already covered between the studies of Åkerlind (2008a) and Brew (2001) as illustrated in the discussion below. There are also other studies about researchers' conceptions from supervisors' perspectives (Bills, 2004; Kiley & Mullins, 2005) and understandably the conceptions were mostly related to the doctoral journey and again already encapsulated in the models discussed below. Hence the two models proposed by Åkerlind, and Brew are used here to discuss researchers' conceptions and experiences of research into two themes: intellectual and process-based.

Research as an intellectual experience

In this thesis the term intellectual refers to research activities such as discovery of knowledge, new understanding, and interpretation (Bent et al., 2007, p. 83). Intellectual development is seen as processes whereby people's knowledge, understanding or reflective or comprehensive capacity or competences are modified (Evans, 2012, p. 427). For my participants, intellectual activities included critically evaluating, appraising, and making decisions in relation to their research project leading to the creation of new knowledge. This section draws on Brew's (2001, p. 280) categories of conceptions of research to present my findings from an intellectual experience angle.

Domino conception

This conception presents research as a linear list of separate elements that are linked together, and they are synthesised to address the research problem; so it is more like a series of tasks to be resolved. It has similarity with some elements of Åkerlind's model such as 'Identify and solve a problem' and seeing research outcomes as 'Concrete products' (Åkerlind, 2008a, p. 25).

> *Reading is critical. Conducting a thorough review of literature, relevant literature […]. Posing appropriate research questions is key. Developing a plan for your research, may be an action plan or a timetable. (Megan)*

I recruit staff to work on bids, I strategically plan a project, I do a project, I monitor and evaluate it, I write the report, I do outcomes, produce datasets, I do media, and so on. (Susan)

These comments show how some researchers approach critical research activities in a linear manner. For example, Megan mentions the tasks involved in the early stages of a typical research project whereas Susan is seeing a wider project life cycle. In both cases the tasks are separate but are linked with each other.

Layer conception

Here the conception is about recognising that the research data contains ideas with hidden layers of meanings to be uncovered through doing the research. The process of engaging with data is important for people with this conception. It has some similarity with elements of Åkerlind's model such as 'Solve a puzzle', 'Discover something new' (Åkerlind, 2008a, p. 25).

like a detective and putting the fragments together and trying to make sense out of the whole (Alice)

the way I do it. I do it very traditionally so for me it's a sort of constant engagement with material, … interpretation that hopefully to sort of get a better perspective of issues. (Patrick)

Alice clearly works like a detective who needs to uncover the hidden truth using the evidence (data) she has. Patrick, however, touches the core of creating new knowledge but emphasises on uncovering it through iterative engagement with data. Both quotations demonstrate the uncovering of underlying meanings.

Trading conception

This conception sees research as enterprising in an academic and social market place, and highlights the value of recognition and reward through exchange of research outcomes. This is somewhat similar to Åkerlind's model, especially with the elements such as 'Become well-known', 'Academic standing', 'Benefits to community', etc. (Åkerlind, 2008a, p. 25).

Engaging with colleagues is a critical aspect so that with things like taking part in seminars and conferences […] also retaining an awareness of the kind of

broader context in which you are operating the broad political context, the REF, funding and that kind of things (Quin)

Bidding for funding to do the research in the first place, that is recruiting the research staff and training and supporting them, […] publications, attending conferences, also increasingly I suppose engaging with non-academics and knowledge transfer type work. (Ursula)

These quotations foreground the business aspects of research such as products, end points, publications, grants and social networks. Researchers seem to exchange these commodities at the research market place such as publications, seminars, and conferences. It also highlights the conception that the market places go beyond the academic community.

Journey conception

This conception highlights the personal aspects of researchers through their issues and dilemmas throughout their career and development as a researcher. Some of these aspects can be highlighted clearly through the dimension of 'Underlying feelings' from Åkerlind's model (Åkerlind, 2008a, p. 25). This is closely related to researchers' emotional aspects of doing the research, and experiences in related contexts. Hence it is discussed later under a separate heading of 'Emotional aspects'.

The four conceptions above highlighted how my researchers saw their experiences from intellectual perspectives. These conceptions focus more on what is happening and what it is about, and less on how it is done. From a technology use perspective, this thesis will examine what roles the use of technology would have in researchers' intellectual activities. The next section examines conceptions of research from the perspective of process-based experiences.

Research as a process-based experience

In this thesis the term process-based refers to systematic or methodical approaches to researcher activities such as organising or structuring of data and facts (Bent et al., 2007, p. 83). Research is very often referred as a process (Åkerlind, 2008a; Ashwin & Case, 2012; Bowden, Green, Barnacle, Cherry, & Usher, 2005; Brannen, 2005; Leshem & Trafford, 2007) and this thesis defines process as the experience of doing tasks and

activities that are involved in realising research. Studies that emphasise research as an intellectual activity (for example, Brew, 2001) often underplay the process and means of achieving the research objects. My study found plenty of evidence of emphasis on non-intellectual aspects such as processes. The participants approached research strategically as well as structurally rather than just from an intellectual perspective. According to Bent et al. research activities comprise investigation, purposeful enquiry; gathering evidence/data; confirming or refuting theories; interpreting; synthesising; and disseminating (Bent et al., 2007, p. 84). In this perspective researchers' procedural engagement is in the forefront. Åkerlind's (2008a, p. 25) model also identifies some of these aspects using the categories: fulfilling requirements, establishing oneself, developing personally and enabling change. Based on E-research, Dutton and Meyer group research activities across various phases of the project:

> Setting an agenda; Assembling collaborative team; Defining the problem; Reviewing the literature; Establishing research question(s) & designs; Conducting ethical review; Locating available data and funding; Developing a proposal; Collecting data; Analysing data; Reporting and visualizing; Getting peer reviewed and published; Archiving (Dutton & Meyer, 2010, p. 168)

In this perspective, each stage is seen as a process that follows from the previous although it does not mean that one cannot jump between them depending on the priority of actions and tasks required to be completed in a particular stage. This emphasises the process-based nature and perspective of research as a series of tasks. However, when referring to research tasks, my participants mentioned a set of tasks similar to Åkerlind's model rather than separately as in Dutton and Meyer's phases. Hence categories of descriptions in Åkerlind's model representing a set of tasks are used below to present researchers' experiences.

Experience of fulfilling requirements

Åkerlind proposes that, in this category, a researcher might try to fulfil their academic duty and the research outcome would be a concrete product through solving a problem. However, the researchers may feel anxiety about, or satisfaction from, fulfilling the requirements.

it is part of wider role of being an academic. So I have administrative things to do, I am currently head of Department, I have teaching that I do, particularly doctoral teaching, and my research is the third strand of that. So officially at my University a third of my time supposed to be spent doing research. (Tony)

In this comment, in addition to being a researcher, Tony is also the head of department who has a range of roles and processes to accomplish. He has to complete his research activities within one third of his total time to meet his academic responsibilities. This could lead to anxiety or satisfaction depending on how successful he is in meeting the requirements.

Experience of establishing oneself

This one is about personal achievement. The pressure to 'become well-known' and established is important in this category. Hence the researcher may have to strategically think about contributing something new that would also have relevance to their own academic standing. This can be risky for them and the feelings may range from frustration to joy.

reading […] analysing data, presenting at conferences, writing and I think a lot of it is also about the more recent, beginning to establish a reputation which is perhaps a little bit more strategic than I like. (Olivia)

Olivia clearly recognises the need to establish a reputation and she aims to focus on recent knowledge in the domain when analysing and presenting at conferences. Her feelings of frustration due to the academic pressure is also evident in the quotation.

Experience of developing personally

The essence of this category is a route to personal understanding. It identifies researcher's focus on personal development and understanding, possibly through a research problem of their interest. Here the underlying feelings experienced are interest and enthusiasm.

staying on top of current research and literature is very important to me and also staying in contact with […] not necessarily just the experts but those working in this field [… and] keeping your general research skills up-to-date […] (Fiona)

Fiona wants to focus on keeping her research skills up-to-date through current literature as well as networking with experts. She appears to take her development as a very important aspect of her being a researcher. She shows an interest in her topic, and enthusiastically

goes out to identify experts and practitioners in her field and engage with them to develop herself.

Experience of enabling change

As a researcher, emancipation and an impetus for change to benefit a larger community is at the heart of this category. Here the intention is to make a contribution to the society through addressing community issues, and the researcher is driven by their passion for the cause.

> *an opportunity to develop thinking and to develop theory and new models of practice and I'm thinking social science in particular … that's very important… Researcher has a crucial role to play in developing the discipline and moving things forward as well. (Raymond)*

For Raymond, it is important for his research outcomes to make contribution to the discipline of social science. He is more passionate about developing the discipline, than himself as a researcher. The driving factor here is making a contribution to the community through research.

The four types of experiences presented above are based on the 'ways of experiencing being a university researcher' identified by Åkerlind. The discussion examined conceptions of research from process-based experiences of researchers. What it shows is that, in addition to the intellectual aspects, there are experiences of actually doing those tasks and activities in completing research projects. There are drivers and emotions that act as impetus. The next section presents some of the emotional experiences of researchers.

Emotional experience

Drawing on the models of Åkerlind (2008a) and Brew (2001), the two sections above discussed research as an intellectual experience, and as a process-based experience. Brew's model does not acknowledge the deeper and underlying emotions experienced by researchers that were an important aspect for my participants. This was however, recognised in Åkerlind's model as a dimension of variations in researchers' experience. Some of these emotional aspects are evident in the process-based experiences discussed above. However, based on the dimension values of Åkerlind's model (2008a, p. 25), this

section examines the variations and range of experiences to highlight some of the emotional aspects of researching. This quotation below from Megan shows an example for Åkerlind's 'anxiety to satisfaction' range.

> *it takes a lot of bravery. You need to be able to come up with new ideas and perceive new ideas… you need to be able to take risks. For example, you know, you need to be able to see that the topic has potential for research, and if it doesn't that can be a disappointment. I think that it's exciting also to be a researcher and this answers your research question but that can also end up in disappointment because you may find that it leads you to discard your initial research idea or take another path or trajectory. (Megan)*

Researchers have to make a lot of small and big decisions as Megan highlights here. The risk of making decisions can lead to anxiety and you have to be brave, as Megan describes it. However, when the projects flow well the researchers are likely to feel immense satisfaction but here Megan's feelings tend more towards anxiety than satisfaction.

Both Kate and Celine below highlight the mixed emotions of frustration and joy in doing research.

> *it's good fun… its intellectually stimulating... its sometimes exciting… it's sometimes hard grind and boring and generally it is very nice actually you know… you are always thinking and developing. (Kate)*

> *I mean fundamentally I enjoy it… find it intellectually stimulating and challenging. A lot of personal development … superficial thing is most of the time it feels frustrating, time consuming... Both positive and negative. (Celine)*

These comments from Kate and Celine show Åkerlind's 'Frustration to joy' range. The joy can come from intellectual stimulation, process completion, personal development, etc. However, when things do not go according to plan, the laborious nature of rigorous research work, slowness of progress, etc. can lead to frustration too.

Åkerlind's 'interest and enthusiasm' range is the focus of the following comment. According to her model this is often associated with personal development aspects.

> *in my current role I am head of Department. So since I have taken on that role, it has been quite difficult in terms of time for research along with my other commitments. […research is] really the part of my job I enjoy the most and find most interesting. So it is something sort of that I had fought quite hard for protecting to have time for. (Ursula)*

Ursula shows that her personal interest in doing research has made her protective of her time for research. In light of other emotions discussed above, this feeling of 'interest and enthusiasm' can be fundamental to surviving the continuing struggle of being a successful researcher.

Åkerlind's 'passionate engagement' element is similar to 'interest and enthusiasm'. However, the difference is that it can be associated more with enabling change both internally (personal) or externally (e.g. social change).

> *it's very exciting I suppose I'm not sure if invigorating is the right word but constantly to be trying to create new knowledge, … to be pushing at the boundaries of a discipline… is immensely stimulating obviously at the ideas associated with the boundaries of that particular discipline. But I think more generally too because it does keep you alert to I suppose the process whereby which knowledge is created and the things we need to do in order to refresh and to renew. (Nelson)*

Nelson shows passion by saying it is invigorating to create new knowledge and developing the discipline (about an external change) and also recognises that it can result in personal development (internal change).

Using dimension values of Åkerlind's model this section showed some of the emotional experiences of my participants. The mixed emotions included anxiety, satisfaction, frustration, joy, interest and enthusiasm, and passionate engagement. The emotional aspect of researching is a less explored concept in literature but I argue that is very much a fundamental part of being a researcher. It has a widespread impact for instance on researchers' workloads, changing roles, effect on researching, pressure to publish and get funding, lonely or collaborative working environment, support needs, and technology use. These aspects are discussed in the sections towards the end of this chapter.

Contextual experience

Previous sections discussed how researchers experience research as intellectual, process-based and emotional. There are other aspects that inform researchers' experience. For example, differences in research traditions and institutional culture, "including differing levels of support for research, facilities available, promotions procedures and teaching loads" could be a factor in how researchers experience research (Brew, 2001, p. 283).

Following from this, some of the contextual issues that would help to examine and understand researchers' technology use are discussed in this section.

Research-teaching nexus

One of the challenges of researchers is dealing with their varied roles, and the workload that it brings with it. These include teaching and administration related workload. Research is seen as a quest for accessing new materials or knowledge and or creating them than transmitting existing knowledge or inspiring others to find them, as in teaching (Prosser et al., 2008; Simons & Elen, 2007). For some of my participants, however, teaching was not a completely separate activity and may often benefit from their research, whilst others note that the teaching responsibilities affect their resource and time for research as in the quotations below:

> *[an] important one is to try and incorporate research into teaching and vice versa. So that students are hearing about research, hearing about what research is and how it works. So that they also hear about the research [that] is relevant to their own studies or around training. (Raymond)*

> *[Researching is a] real privilege I think. It's exciting, it's interesting, it's challenging, it's intellectually stimulating, it's one of the best parts of the job which is why it's so frustrating, that the job prohibits. The nature of the job prohibits you really getting your teeth into it when you've got a big teaching and administration load. (Julia)*

Raymond finds that his teaching and research complements each other. He also sees its value of teaching as an opportunity to share his research with students. In the case of Julia, the teaching load is so onerous that it prohibits her from doing research. For a researcher, the task of teaching can be different from researching in many ways. A functional approach would consider researching and teaching as two distinct activities (Simons & Elen, 2007, p. 623). However, the idealistic approach does not regard research and education as different activities, but research process as a form of education (Simons & Elen, 2007, p. 626). There are plenty of literature that examines the relationship between research and teaching, and argues for having a closer link between them (Brew, 2006; Macfarlane & Hughes, 2009; Malcolm, 2014; Tight, 2016a). Universities in UK now have to respond to Research Excellence Framework (REF, 2014) and Teaching Excellence and Student Outcomes Framework (HEFCE, 2016). Although they are assessed separately, arguably, it

highlights how research and teaching are given similar importance in the Higher Education policy context.

Researchers in my study had mixed responses about this research-teaching nexus; some did not differentiate research and teaching while others highlighted what the differences were as in the example below:

> *I mean as a researcher it's much more about me. I'm the centre and the people collaborating with… I don't really do much research at work… I do it at home where there aren't people… There is some collaboration but say when you are writing up, when you are writing stuff that's just something you do on your own really. Whereas teaching is much more collaborative. It takes a lot more energy, I have to say, there's teaching and the other roles and you have to be more present for those here [at the University]. … I would say that they [teaching] are much more situated in the university, where as my research world is more distributed. (Kate)*

Kate does not see her research and teaching as similar and differentiates it using various aspects such as nature of activity, drive, engagement levels and context. The responses from my participants, including Kate's, are synthesised and contrasted below to discuss this further.

When comparing with research activities, the participants of my study saw teaching as presenting information and inspiring students to do their own analysis and critical evaluation. In other words, the researchers in their teaching role, are only facilitating the research and learning activities of students. Teaching appeared to be more collaborative and situated at the institutional setting. The teacher had to be present in the context and invest more energy to explain grass root level content which often had a repetitive nature. For some, it was a task they had to do with no freedom to teach on their areas of interest or expertise. Many do not get a chance to speak about their research (or could only do theoretically) in their teaching unless when teaching research philosophy or methods. However, some researchers use things from their research in teaching and also encourage students to do research.

Similarly, when contrasting with teaching, for my participants, research was more about doing analysis, critically evaluating, finding gaps in knowledge, creating new knowledge, etc. rather than inspiring others to do it. Many researchers highlighted the different nature

of effort required for research as it is often a very unknown journey, mostly lonely or pretty much by oneself. Researchers like Kate saw research as more distributed rather than just being at the location of work. They often had to do it at home, in their own time, outside working hours and had less people to check with until it is all written. However, researching was seen by some researchers as having quite a lot of overlap with teaching despite the audience of research being different (funders, journal readers, conferences, etc.) than students. Some researchers did not differentiate at all and were not even aware when they switched from one role to the other. Regardless, many suggested that research informed, enriched or enhanced their teaching with current and up-to-date sources.

From the findings above, it was interesting to note that researchers talked about the 'link' their research had with teaching than similarities between the two otherwise separate activities. Although the questions around the value of research-teaching link is not fully answered yet (Malcolm, 2014, p. 296) there are many useful explanations pointing to the differentiation. One suggestion is that it could depend on how academics see their teaching and research as either isolated packets of knowledge or holistically with links to the wider field (Trigwell & Prosser, 2009, p. 325). Another one is whether the teaching-learning process is experienced as something that has no benefit to their research, or experienced as potentially extending their understanding of subjects (Åkerlind, 2004, p. 374). In both cases, the latter options demonstrate a stronger link with research. The data and literature show that the link is there in terms of teaching and research informing each other. But the critical examination above reveals a range of aspects that makes research different from teaching. There is clearly an effort in dealing with switching between the demands of these two aspects of their role.

From the differences highlighted above between research and teaching it could be argued that there could also be potential differences in use of technology for research compared to teaching and learning. For example, lack of time may deter them from learning and using a technology for their research activities. Also, if teaching and research are seen as closely linked they might also use the same technology for both which would have implications for their choice, use and adoption of technology. These aspects are examined in Chapters 5 and 7.

Collaborating beyond academia

In addition to their traditional workload, researchers are now increasingly expected to engage with the 'third strand' of activities at institutions. Bent et al. note that:

> While teaching and research are clearly central to the idea of a university, the importance of 'third strand' activities involving university relations with business, industry and the regional agenda is being increasingly recognised. Initially, 'third strand' activities were defined as anything other than the universities' core business of teaching and research. However, an integrated 'third strand' programme can complement a University's established teaching and research activity and such programmes are now becoming embedded - and sustained - within university culture (Bent et al., 2007, p. 88).

The 'third strand' is about taking the researchers role beyond teaching and researching at the institution, to collaborating with external bodies and businesses. This is evident earlier in this chapter where the research participant quotations from Susan (under the section Domino conception) and Ursula (under the section Trading conception) mention about bidding for funding and strategically managing project to produce datasets and disseminate it. This is a changing culture for universities in the increasingly competitive times for research funding. This mostly affects established academic staff and senior researchers, especially in terms of restricting their freedom in what topics they can research about, and how those topics relate to businesses (Bent et al., 2007, p. 87).

The challenges discussed above in terms of research-teaching nexus and collaborating beyond academia are part of the experienced researchers' professional activities. It is important to be aware of such contextual issues while examining and understanding researchers' technology use especially when technology is seen as an enabler.

Need for efficiency and axioms of technology as an enabler

From the analysis it was evident that there were wide range of activities that are critical to researchers. The huge pressure to juggle such activities and keeping up-to-date with the knowledge in their field was commonplace among my participants. As discussed earlier researchers are already doing these activities in their own time and often at home. Since the time to meet all these without compromising quality and rigour were precious researchers were keen to seek avenues of efficiency gains.

This chapter showed evidence of researchers enjoying and valuing research. However, the challenges are the diverse workload, scarcity of time, and access to resources and support. In effect researchers are looking for efficiency gains and technology use has been seen as one of the enablers.

> *[technology] sped things up for me. Made things available or had affordances. I think it would have just taken a lot longer, and I just don't think … [I would have] come to the same conclusions because you haven't got that sort of helpfulness of it. It [technology] pulling certain things together or highlighting suddenly [from data] that so many people have said. I think it really did help with analysis process. (Fiona)*

> *You can handle large amounts of data very easily and you know you can easily contact people without having to travel to meet them. So the benefits are also saves you time. It's cost-effective in terms of your time. (Wendy)*

Fiona highlights some of the key affordances of technology, such as making things accessible and doing things faster. It also enabled her to do deeper analysis as technology helps to highlight patterns that are not easily visible to humans. Building on this Wendy picks on the affordances of technology to manage significantly large volumes of data which is impossible for humans. Enabling communication between long distance in a time-saving and cost-effective way is also highlighted here as some of the key technology benefits.

Almost all research activities now involve some form of technology. People take it as a given that technology is an enabler and helps even in their everyday tasks (see "Life is Digital" in Lupton, 2014). There is plenty of evidence in educational roles and contexts that technology is an enabler; for example, technology enhancement in teaching and learning (Kirkwood & Price, 2014), use of technology by postgraduate researchers (Carpenter et al., 2012), and eResearch in educational inquiry (Markauskaite, 2010). In research, the government, funding bodies and research councils are investing in technical infrastructure and projects to take the technology use forward (CST - Council for Science and Technology, 2010; European Commission, 2015; Morrell, 2014; RCUK, 2010). So clearly the value of technology is recognised and taken as a given. In other words, it is accepted as an axiom.

Something being useful does not necessarily mean that people would use it. Interestingly my study found a juxtaposing position here. The researchers had heard of, or are aware of

the benefits of technology but they do not necessarily use it as much. They agree that technology does not hinder research and, in fact, there are almost no phases or activities that it cannot help (Appukuttan, 2015, p. 33). Perhaps an exception might be thinking and decision making. Yet my study found that the majority of my participant researchers are not able to use many of the technologies they already have access to in an effective way. The comments below show two different perspectives.

> *Because [technology] makes us to work in a level playing field. Because all have equal access. If somebody is attached to an institution they have equal access to the materials or otherwise we can use our networks and access to the material. So it is easily available. So I like that level playing field in academy. (Xavier)*

> *yes, I agree, … use of technology can be fantastic. Well it can help you understand things that you maybe couldn't understand in the past. But sadly from my point of research, where I am pretty much getting people's voices who aren't usually included that needs a different approach. (Quin)*

Xavier shows how technology use contributes to equal opportunity for researchers by making resources which otherwise would have been inaccessible. This is significant especially in the time of the REF and third strand responsibilities discussed earlier. While Quin agrees to this line of thinking, she feels some of the affordances of technology may not be suitable for her research context and approach. The question here is why does she feel that. Would she use it in another context? What informs that choice? This warrants examining and understanding researchers' use of technology further. How do educational researchers use technology and how far it enables them to conduct their research? Does it help with intellectual activities or process-based activities? This conception of 'technology' is the point of departure for researchers to inform their conception of 'technology use' for their research activities and is discussed in Chapters 5, 6 and 7.

Chapter conclusions

This chapter has analysed and presented the varied experiences of researchers. The significant pressure on researchers in addition to conducting research are evident in my study and the findings are in line with existing literature discussed in Chapter 2. Analysing the varied experiences with two existing models (Åkerlind, 2008a; Brew, 2001), my study has encapsulated researchers' experiences into four categories; that is, research as

intellectual, process-based, emotional and contextual experiences. There were clear evidences of researchers enjoying and valuing research both as an intellectual and process-based activity. Experiences of research activities were more than just production and dissemination of research; it included teaching and other administrative activities as well. My participants had varied conceptions of research-teaching nexus, and also experienced clear differences between conducting research, teaching and other roles. The 'third strand' of work took their role beyond teaching and researching to collaborating with external bodies and businesses. My study has highlighted these pressures on the researcher referring to the institutional emphasis on securing funding and activities beyond academia.

The key challenges for researchers included diverse workload, scarcity of time, and access to resources and support, etc. As summarised in the literature review (see Chapter 2) my participants also often dealt with the common challenges individually. Many were engaging in research related activities in their own time and often at home. The study also noted the emotional aspects of working through such pressures and challenges which, I argue, is a fundamental part of being a researcher.

Based on the discussion above it is argued that there could be potential differences in use of technology for research activities compared to teaching and learning. In order to manage the varied challenges without compromising quality and rigour, researchers were open to seek new avenues for efficiency gains and they really valued the use of technology. However, my study found that, although researchers were aware of the benefits of using technology they still may not use it.

The challenges discussed above in terms of research-teaching nexus and collaborating beyond academia are part of experienced researchers' professional activities. It is important to be aware of such contextual issues while examining and understanding researchers' technology use especially when technology is seen as an enabler. The next chapter will examine the characteristics and issues of using technologies for research. Further chapters will examine and discuss researchers' experiences and conceptions of technology use.

Chapter 5: Researchers and technology use

This chapter presents the background to researchers' use of technology and analyses related key issues. The aim of this study was to understand more about the use of technology by experienced non-STEM researchers. The previous chapter, in answering the first research question, examined researchers' varied experiences of doing research using two existing models of research and identified some key aspects that could inform their technology use. This chapter addresses the second research question and identifies the types of technologies researchers used and how they used them.

The chapter starts with a vignette which presents a typical scenario developed from a combination of experiences of different participants. Drawing on it, the chapter discusses the range of technologies researchers used, their varied conceptions of technology, and discusses their awareness of the benefits and effects of using technology. It then presents two key observations in terms of how participant researchers used technology and explains them using the SAMR model. Based on the vignette and participant quotations this chapter discusses researchers' challenges and argues that skills development and support are important aspects that inform researchers' use of technology.

A vignette

My participant researchers experienced research mostly as a lonely process compared to their teaching or other collaborative activities. Many researchers were open to or even excited about using technology and its prospects. Some resorted to social media for networking in terms of peer support and dissemination of their research. Nevertheless, research activities in practice took place in isolation and when things went wrong they could not often access the advice and support they needed. This highlights the importance of technology related skills development and support if researchers are to be successfully using the technology. Such experiences among participants are combined and presented as a single vignette rather than individual quotations.

Miles and Huberman (1994, p. 81) suggest that vignettes elicit representative and meaningful data that "can be pulled together in a focused way for interim understanding". They define vignettes as:

> "…a focused description of a series of events taken to be representative, typical, or emblematic in the case you are doing. It has a narrative, storylike structure that preserves chronological flow and that normally is limited to a brief time span, to one or a few key actors, to a bounded space, or to all three" (Miles & Huberman, 1994, p. 81)

As Miles and Huberman suggest the following vignette combines some typical representative experiences from multiple participants and presents a short narrative. It was adapted from my journal article (Appukuttan, 2015, p. 34) based on the interim findings of this study. It has sufficient context to provide an understanding about the situation being depicted (Barter & Renold, 1999, section: Implementation of vignettes) and to illustrate some of the challenges my participant researchers faced.

> **Vignette: Changes in technology and learning curve - (Appukuttan, 2015, p. 34) (Modified version)**
>
> It is Sunday 9.00 p.m. Linda decided to indulge herself with half a glass of wine. It takes about 7 minutes for the laptop to start and be ready for use. She has lots of institutional software on the laptop such as the full Office software suite, email clients, multiple internet browsers, video meeting tools, audio editing and transcription software, multiple versions of the reference manager, statistical analysis tools, and a new version of a qualitative data analysis software. In addition, the laptop had already come with a lot of software that she has no use for whatsoever; all they do is slow the machine down. Not to mention the millions of windows that keep popping up which she has to close down one by one before she can start her work. So she had plenty of time to enjoy a sip or two. She wanted to make a start on analysing the large amount of data collected for a research project and is under pressure to finish the analysis quite soon. She thought it would be useful to do it electronically as it will be easy to share and collaborate with two other researchers in the team. She loaded the qualitative data analysis software that was installed on her laptop and started reading the notes on the exercise file she had from a training session. However, the software looked nothing like the training she had 6 months ago. Linda felt very confused. She had a look at the wine glass and then the bottle; and wondered "it's not the wine, is it?" She looked at the help options within the software. After an hour she had reached nowhere. Disheartened, finally she gets her scissors and envelopes out. She starts reading and cutting the printed data and sorts them into groups before putting them in labelled envelopes as she has always done; she knows that it will work. She doesn't bother about the laptop that had gone dark because the battery was dead. She doubts whether she will ever bother with that software again.

The vignette encapsulates a range of issues but mainly highlights that the persistence and commitment from researchers may not be enough and the e-Infrastructure needs to meet the promised expectations in terms of reliability and skills development. In addition, the technology support systems need to be accessible when it is required. The vignette above has set the scene here and will be referred to again after considering some related issues, starting with the range of technologies used.

Range of technologies used

Similar to the technologies mentioned in the vignette, my participant researchers used a wide range of technologies from *pencil* to *AMOS* (structural equation modelling software), and from hardware and software to web/cloud based research databases and communication technologies (see Appendix 4a: List of technologies used by participants; sorted by the number of researchers who used it). Other types of tools used were based on whether the content was dealt with on their local computer or over the internet. The latter often had another layer of complexity of security, and need for internet connection. None of the researchers had mentioned problems with internet connections which could mean two things. One could be that my participants did not use any tools or content that had a demanding load in terms of internet connectivity such as huge file transfers, or use of process-heavy and resource hungry applications over the internet. In other words, they did not need any high power computing yet. The second could be that they had reasonably stable internet connections with adequate speed to do their research activities.

Analysis showed that the technologies that were stable and less affected by regular changes and had proven affordances and purposes (for example, pen, paper, telephone, word processing software, presentation software, etc.) were used for research as well as for other purposes. However, the VLE seemed to be a non-research tool/concept; so does Turnitin, Video Conferencing, Webinar software, etc. which were used for other activities such as teaching. It also appeared that researchers may be aware of the benefits and have skills in using certain tools however, they would not always want to use it in their research. For example, among my participants, it was found that Skype, YouTube, etc. are used more in non-research activities than research activities.

Conceptions of technology

The range of technologies discussed above shows the variation among researchers in terms of what they regarded as technology in different contexts. Some of them often referred to technology as a means to an end. Heidegger (1977, p. 4), in his essay *the Question Concerning Technology,* asserts that "technology is a human activity" as "to posit ends and procure and utilize the means to them is a human activity". In other words, using technology to address their needs is in the human nature. Keeping the definition of technology open to my participants' interpretation was thus useful in capturing the variation. For my participants, the term technology had a broader meaning than just digital technologies as it included a range of tools (see Appendix 4a). However, it was interesting to note the similarities and differences in how researchers conceptualised the meaning of technology in general or everyday context (that is, non-research context) compared to research specific context. A closer analysis showed that, for some researchers, it was the same in both contexts but for others, completely different (refer to Appendix 4b for conceptions of technology grouped into themes). From the data, it was identified that, participants had conceptualised technology in five key ways as: an object, an affordance, an effect on their activities, an emotional feeling, and a type of professional development. The last one was specifically identified in the context of research. All of these are outlined below.

An object: technology was seen as a broader term than just computers. That is anything that is more than themselves (human), any electronic or non-electronic tool, from pencil and paper to musical instruments, all kinds of computing and communication devices including hardware, software, information and digital technologies. In terms of research, in addition to the above, technology was also seen as an interface to an issue or a tool for the research job.

An affordance: some researchers saw technology as having affordances that enable them to achieve goals rather than just as an object as in the previous case. This included affordances that are simple or complex, new or already diffused among users, and things that enable access to and makes tasks simpler and easier. They also saw technology as

an application of affordances in terms of assisting to save time and improve efficiency, mostly for processes such as networking, communication and management of information. Sometimes it was also referred to as innovative (affordances) providing new opportunities. In addition, technology was also seen as useful in research tasks such as data management, analysis and dissemination.

An effect on activities: Building on the two types of conceptions above sometimes technology was referred to as something that causes an effect such as changed ways of working and affecting and shaping human action and more generally as a digital impact. In this conception, technology was referred to as something that changes research fundamentally and can have far reaching impact, in that it can shape the research and can also be shaped by research. Technology was also seen as something that raises researcher expectations to improve research and provide robust answers, facilitate new types of research and in some cases even does the research for the researchers. Technology was also seen as something that has an indirect effect on all researchers because of other researchers' technology generated content which they will have to draw and build on.

An emotional feeling: there was an emotional meaning associated with technology which ranged from excitement to phobia. For some, technology was something that they could not work without while for others, it was something new to learn and just a facilitator. In terms of research there was more cautious excitement acknowledging the three conceptions above. Researchers were concerned about losing the traditional sense of doing research and hence kept technology separate from research.

A professional development: technology was also seen as a form of continuing professional development (CPD). Researchers felt it was something that they needed to invest time in to master, and then seek follow-up support as and when required. Some researchers saw technology as a topic of research in itself, for example, technology enhanced learning.

These five varied conceptions of technology among researchers outlined above were not always experienced in a mutually exclusive way but as a combination and also differently in

different contexts. That is, a researcher might conceptualise technology as an object as well as an affordance but perhaps later just as an emotional feeling depending on the positive or negative experience. In the vignette we can see the conceptions of technology as an object (laptop), an affordance (qualitative data analysis), and an emotion (confused or disheartened) however, not necessarily as professional development (although she draws on the training) or as an effect. All such conceptions inform how they experienced the use of technology in their research activities. A deeper analysis of relevant conceptions of technology use in research are illustrated with quotations in Chapter 6, where it is argued that CPD or developmental conception in terms of training and support is important and would be one of the dimensions of variations in how researchers experience technology use.

Awareness of benefits and effects

Regardless of the varied conceptions above, participants of the study were aware of the benefits of technology use and they acknowledged that they use (or would use) it in all phases of their research. These important insights about researchers' use of technology are discussed in Appukuttan (2015, pp. 33–34). Researchers were aware that their technology use could have an effect on their research. They were asked whether technology use helps or hinders their research. As Figure 8 shows all those who answered the question agreed that it helps or at least it does not hinder their research (Appukuttan, 2015, p. 33). Benefits mentioned by researchers included improved process efficiency, sourcing research information and its systematic management, and easier communication and networking.

Chapter 2 referred to various phases of research (Dutton & Meyer, 2010, p. 168). During the interview, after considering these phases most participants thought that they would use technology in 'all phases' of a research project. That is, they would use technology from setting an agenda to archiving all research resources. However, some researchers were not sure whether they would use technology when they are thinking and making decisions such as defining a research problem, posing questions, or doing ethical reviews.

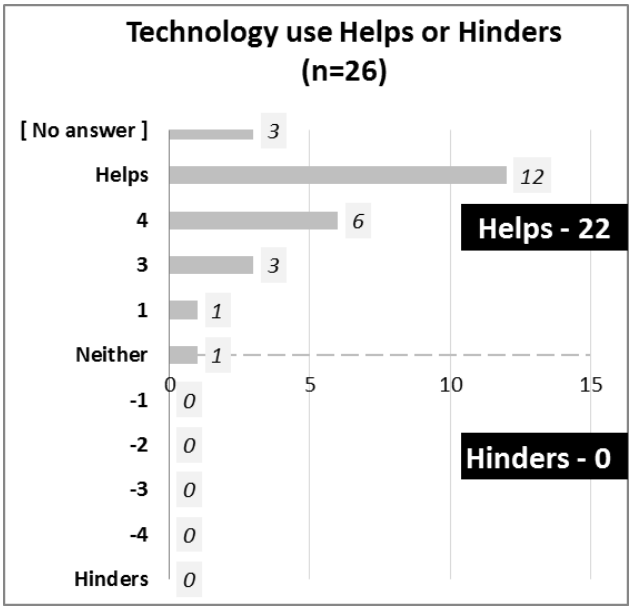

Figure 8: Technology use Helps or Hinders (Appukuttan, 2015)

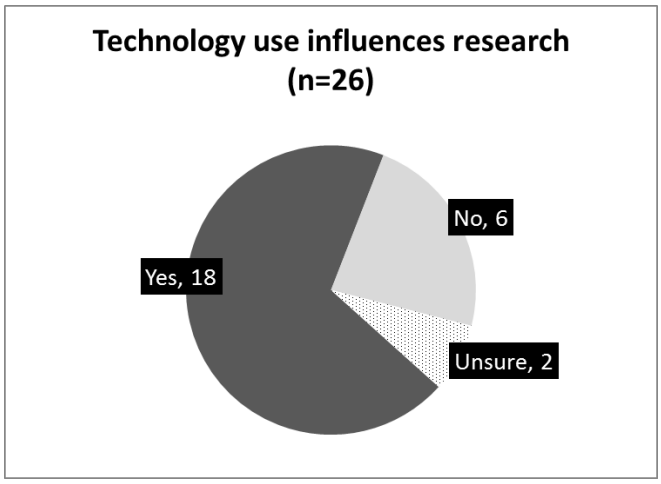

Figure 9: Technology use influences research (Appukuttan, 2015)

When asked about the effect of technology use on their research, as in Figure 9, the majority of my participants thought it would influence their research (Appukuttan, 2015, p. 34). In summary, researchers were aware of the benefits of using technology and the effect it could have on their research. Interestingly the analysis showed evidence of researchers settling for familiar technologies rather than exploring further. That is, sometimes, the familiarity with a particular technology was seen as more convenient than seeking efficiency or other gains that a new technology could have brought.

Approaches to technology use

From the analysis two key observations were made about researchers' approaches to the use of technology. First, the technologies they used most were either already diffused (widely adopted) ones or specifically needed for research activities. Second, the majority of technology uses were driven by the research aims and used mainly for process-based tasks. There were only limited instances where technology uses informed research aims and used for intellectual tasks.

Observation 1

The first observation was around how much the technologies were diffused or were part of everyday life. Similar to tools such as pen and paper, now word processors, emails, etc. are also integrated within academic activities to the extent that these are confidently used for higher level functions that it was not originally intended for – such as using MS Word for coding research data. In other words, its affordances were utilised effectively. Also these tools have evolved and stood the test of time and user friendliness. This raises further questions such as whether new and short-lived technologies are of less use and interest to researchers.

The analysis showed that tools commonly used for other tasks also get used in research activities. Two different usage patterns were prominent in how researchers approached technology use: 1) already diffused and 2) specifically required**.** Diffused technologies were used in non-research context or everyday activities and researchers were comfortable in using them. However, there were specific technologies required for particular research contexts. Such usage is evident in the quotation from Alice below:

> *[technology has] become so much a part of day to day life … It's just something you use now as a means of communication and yes, when I'm using Word I do like things like the sort button and so on for charts. …whereas Endnote is something that I would only be using for research, yet email [might be] something you would use to talk to your Dad. (Alice)*

The comment shows that Alice uses Word and email in non-research or everyday context whereas Endnote is specifically for research. This was evident from the analysis of technologies used, and where they were used as discussed below.

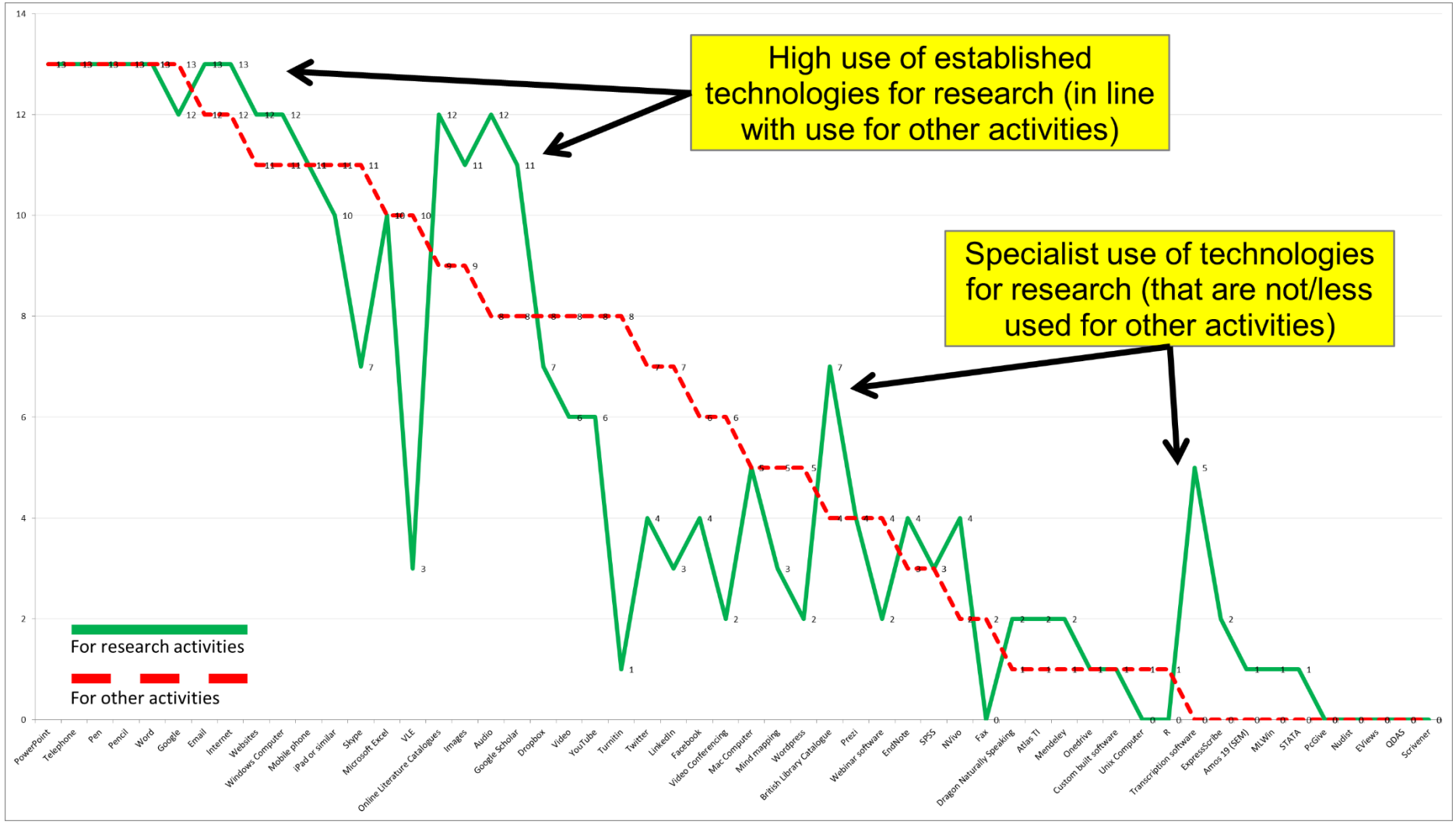

Figure 10: Technologies already diffused or specifically needed for research activities

Figure 10 shows high usage of established technologies for research (in line with use for other activities) and specialist use of technologies for research (that are not/less used for other activities). Not surprisingly, the established and widely used technologies in other contexts were also heavily used for research activities. This implies that researchers are careful when investing their time in adopting technologies and developing their skills if they are either not already familiar of its affordances, or has other compelling reasons to use them. Investment in learning and using specialist tools were not in trend among non-STEM researchers, and arguably, technology held a secondary role (or just a means) to the research (an end). However, the study found some evidence of use of specialist tools for research that they did not use in other contexts. This suggests that non-STEM researchers have invested in adopting new tools where they consider it to be necessary and of value to them.

Observation 2

The second observation was about drivers and foci of technology use. In Chapter 4 the different ways researchers experienced research activities included intellectual and process-based. Analysis showed that researchers used research aims to drive their technology use and the usage was mostly for process-based tasks rather than intellectual tasks (see darker arrow in Figure 11). Instances where technology use informs research aims and intellectual tasks were very limited (dotted arrow in Figure 11).

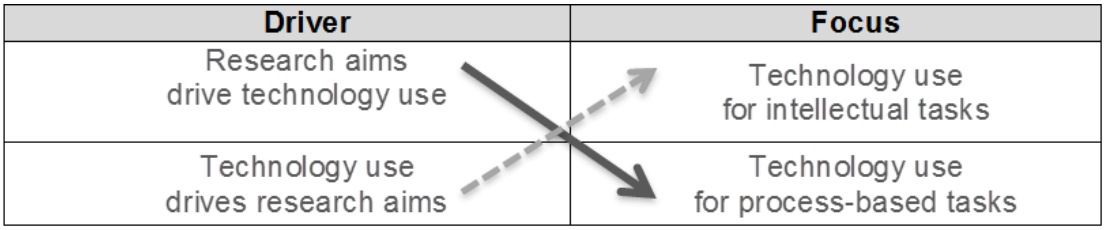

Figure 11: Drivers and foci of technology use

As seen in the vignette earlier in this chapter, researchers had to set up and manage their own tools at home, and without the development and support they were less likely to use it. Some researchers saw it as a disruption to their research work or only used it as a substitute for their existing ways of doing things. Drawing on their conception of technology

as affordances, some other researchers valued the benefits and used technology for functional improvements of mechanical and laborious tasks such as content editing and formatting as well as researcher specific tasks such as data management, communication and networking (Appukuttan, 2015, p. 35).

Applying the SAMR model (Puentedura, 2013, p. 5), introduced in Chapter 2, to my analysis showed that participant researchers stayed mostly at the 'Enhancement' half, that is 'Substitution' (technology as a direct tool substitute, with no functional change) and 'Augmentation' (with functional improvement) levels, with very limited signs of being at the 'Transformation' half, that is 'Modification' (significant task redesign) and 'Redefinition' (creation of new tasks, previously inconceivable) levels. This is in line with the second observation, in that, instances where technology use informs research questions and its use for intellectual tasks (equivalent to 'Transformation' half) were very limited among researchers.

Challenges of technology use

As illustrated in the vignette, while researchers value the benefits of using technology they often struggle with it due to lack of timely development and support. Researchers are experts in their fields and confident in doing the research activities but use of technology is where they really could do with some serious help. My participants were aware of the need for discernment when using technology and pointed out issues such as drawbacks of using technology, need for managing it, and various distractions it could cause.

Being aware of a technology or its need in their research was followed by issues of having access to those technologies and the relevant support in using them (Appukuttan, 2015, p. 35). For many researchers, access was a challenge in its many forms such as: knowing about the technology and its affordances; having access to the right technology; then accessing them in practice and developing skills; cost and licence issues, etc. Among all these, receiving support for the tools was a key challenge as it was often generic and not specialised or contextually explained for researchers. The next resort for experienced researchers was to attend training and development programmes.

Researchers saw technology as something that needs professional development, in a more negative than positive way. While technology brings benefits to their research there were also concerns around the lack of awareness and understanding of technology affordances. Some felt technology is something that they are forced to use and must embrace. Training programmes were also aimed predominantly at postgraduate or new researchers, and that too at basic or introductory level. In addition, researchers often worked on a fixed timescale for their projects but the training programmes were not available when they needed it. Training too early before the need arises was not fruitful either as researchers eventually forgot its use by the time they needed the technology or they would probably have a newer version of the tool which would have changed its interface, functionality, and compatibility with older versions. This is illustrated in the vignette where it was 6 months since Linda had the training, and by the time she wanted to use the software it was a different version making it confusing. The next section briefly discusses relevant researcher development issues and suggests it as a critical aspect of researchers' experience of technology use.

Importance of researcher development for technology use

Technology use for research is different to other academic activities such as teaching where the same technology is used by more people regularly, and has more established training and support mechanisms which are available at an institutional level. Use of technology in research is somewhat different. In STEM research where specialist technologies are in use, the technology could be delimited in its research environment and labs with clear boundaries whereas, based on my study, non-STEM researchers use relatively low-cost and individually manageable technologies which could be less separated from their everyday life. This means the access to and support for technology use have different challenges.

Regardless of the conceptions of technology, technologies that are embedded in researchers' activities seem to enhance their research if it is not seen as separate from the research processes itself. New technologies take time to get embedded and will only survive in terms of their use in research if it has timeless value (for example, pen and

paper) or the learning investment is worth it in the long-term and perhaps also in other activities in researchers' life. This is where technology training becomes relevant.

Researchers' development in technology use has a range of issues. The quotation below is an example of less strategic approach to technology training and development for researchers.

> *It's like they will deliver training and I'll go on it, cos I'll think oh that might be useful. And then you don't embed it, it doesn't become embedded in practice, and then you forget about it. And then its like oh, I need to go for another one now. (Quin)*

Quin's concerns have been widely shared among participant researchers. Comprehensive training becomes less useful as the researchers often forget functionalities if they are not applied sooner in a project. In addition, a new version of the same tool might come out which means researchers might have to upgrade and retrain. Having said that, exposure to technology and its affordance has considerable benefits as evident from the comment below.

> *if I had known how good Skype was I would have probably used it in my research… I can now see the potential of many of this [list of tools] (Edwin)*

Here Edwin shows disappointment in the missed opportunities and now excitement because he understands the potential and even might think of new possibilities it could bring to his research. This would somewhat contradict with the issue of training too early and then forgetting. Edwin's comment means early introduction and taster training on proven tools will be of use even if researchers do not know eventually what technology they might use and how. In fact, if they know what technology can do, it might even shape their research. Thus, technology awareness does have an effect on research activities and hence its outcome.

A possible explanation of mixed approaches to development among researchers is that, some experienced researchers were experts in using technology when they started their research journey and were up-to-date with available technologies. As years passed by the researchers were able to achieve their research objectives with the tools and technologies that they were already familiar with and hence there was no impetus to explore new ones.

Technology has been evolving rapidly although many were not stable and became obsolete very quickly. So it made sense for researchers to wait and watch. Eventfully, researchers missed the new developments to the extent that the learning curve was too steep to invest in. This led to ignoring or dismissing and surviving with technologies researchers were already familiar with, resulting in limiting the scope and potential of using technology. This meant the opportunity to combine and power-up experienced researchers' expertise with technological advances had been lost.

Being open to trying technologies sometimes makes a difference. Face-to-face training was the preferred medium compared to online and printed resources. My participant researchers where sometimes inspired by how their peers used certain technologies and often sought peer advice rather than training. Peer support was reliable for some researchers however, from a broader perspective, it appeared to be inconsistent, not quality controlled/assured, and in effect, mostly depended on the luck of researchers having access to relevant and technically skilled peers.

In summary, conceptions of technology may not have a direct effect on researchers' use of technology. However, awareness of affordances and benefits of technology to their research; and resources and opportunities to address the challenges of using it, could have an effect on their approaches to using technology for research activities. This is where appropriate researcher development for technology use would play the crucial role and become an important aspect of using technology.

Chapter conclusions

This chapter has provided a snapshot of researchers' front line experiences of using technology and highlighted the range of tools and contexts. Compared to their conceptions of technology, researchers' awareness of its affordances and benefits, and how they used it in other activities, had a bearing on how they used it for research. However, technology as professional development was an important conception in the context of research. It was evident that researchers were aware of the benefits of using technology and its effects on their research; however, they tend to use the tools they are already familiar with rather than exploring new tools. Even if they did, they were cautious and discerned the right tool for

them and stuck with it. Their approach to usage seemed to be informed by research aims and predominantly for process-based tasks. Instances of technology informing research and using it for intellectual activities were limited. In addition, the vignette has illustrated that despite the best efforts researchers could feel let down by the issues of access to relevant technologies, its constantly evolving nature, limited support and development, etc. This could eventually put them off from further use of technology.

This chapter argues that professional development is key to researchers' effective use of technology. Researchers valued face-to-face training and peer support. The ways in which their peers used certain technologies also inspired them. Although each specialist need of researchers cannot be supported by institutions, they could invest strategically in e-Infrastructure and use specialist advisors to expose the affordances it brings with contextual advice and support. Such approaches could help reduce the knowledge burden on researchers in terms of developing their technological skills. This would be important for researchers in developing an understanding of technology use for research. This developmental angle is used in the next chapter as a critical aspect to explain the varied ways researchers experience technology. Awareness of such variations would also enhance their own understanding of technology use and could form part of researcher development.

Chapter 6: Varied experiences of technology use

Introduction

This study aimed to understand the use of technology by experienced non-STEM researchers. The previous two chapters addressed the first two research questions and analysed researchers' experiences of conducting research, and their experiences of using technology. This chapter answers the third research question on the varied ways in which researchers experience or conceptualise technology use. This is achieved by a phenomenographic analysis of researchers' accounts of their experiences of using technology.

The premise of phenomenography is that a phenomenon can be experienced in varied ways and that variation can be explained as "a question of discerning and becoming focally and simultaneously aware of all the relevant aspects" of the phenomenon (Marton & Booth, 1997, p. 122). An aspect means a common characteristic of that phenomenon which can also be experienced differently by different people in different situations and contexts. For example, the experience of the phenomenon of 'listening to music' can be varied based on the aspect of 'emotion'. In phenomenography, the values of variation such as happy, sad, ambivalent, etc. will be known as 'features' of the aspect 'emotion'. This helps to explain when someone describing their experience of 'listening to music' as 'sad' by understanding its focus on the aspect 'emotion', but not necessarily the 'instruments used'. In turn, instruments used could be another aspect which would have features (values) such as wind instruments, percussion, etc. There will be many such aspects to the phenomenon of 'listening to music' but some of them will be critical when listeners explain their experiences. Those who report "feeling happy listening to percussion" exhibit two critical aspects in their focal awareness simultaneously – 'instruments used' and 'emotions'. Those who report that "my type of music has to be a live performance of saxophone" focus on the aspects 'instruments used' and the 'medium of delivery' (as in whether it is live, recorded, etc.). This approach is used in phenomenography to understand and explain not only the various experiences but also the structure of those experiences and the relationships between them. For example, in the first case we can see the structure as emotion and

instruments used, and in the second one it has instruments used and the medium. By bringing such varied experiences together we can begin to understand the structure of experiencing the phenomenon of 'listening to music' in terms of such critical aspects, upon which the various listeners focus on at any given point in time.

This example illustrated how the experiences of only two people have identified three critical aspects out of many other possible aspects that the listeners could have mentioned. However, Marton and Booth (1997, p. 122) assert that "even one person's experience of one particular phenomenon is inexhaustible". This means the different ways we describe the experience is only a sub-set of all the possible ways to experience that phenomenon and its critical aspects. Thus, the findings of my phenomenographic research will be limited to my study, and driven by its aims.

It is possible that a researcher can experience the phenomena of technology use in varied ways depending on the context and a range of other factors. However, there will be commonalities in these varied ways of experiencing. Understanding the aspects of such variations and commonalities would contribute to abstracting the potentially huge range of variations into a limited number of qualitatively different groups of varied experiences (Marton, 1981, p. 181). In the phenomenographic approach such abstract groups of experiences are labelled as 'categories of description' as they are based on how the phenomenon is described as experienced by the people. It is important to note that the varied categories are constituted based on all interview transcripts rather than each individual transcript, and one transcript may contain elements of more than one category (Ashwin, 2006, p. 655). Similarly, the critical aspects of variations and commonalities in the ways of experiencing are known as 'dimensions of variations'. These varied ways of experiencing are then presented diagrammatically as an outcome space.

According to the norm (Åkerlind et al., 2005, p. 95) findings of phenomenographic studies start with a description of the 'outcome space' (in either prose or graphic form or both) followed by an elaboration of the categories of description and an analysis of the relationships among categories based on the dimensions of variations. However, I have presented these below in the reverse order for clarity of argument. The next section starts

with identifying the dimensions of variation and discusses how the combination of experiencing and simultaneously discerning them leads to proposing different categories of descriptions. Categories and dimensions are then presented as an outcome space with a further discussion on the relationship between the categories.

Dimensions of variation

A researcher, at a given moment, might experience technology use differently depending up on the critical aspect or aspects they have in their focal awareness simultaneously (Pang & Ki, 2016, p. 323). Hence, to understand why and how their experiences are varied, first the critical aspects in terms of dimensions of variation of technology use had to be identified. Dimensions of variations provide the structural aspects of an experience. Normally a dimension would have different values or features that will be discerned by users. For example, when colour is a dimension, the values discerned by people are red, green, blue, yellow, etc. In this case, my dimensions were conceptual and did not have specific values or features within the scope of this research. Moreover, the focus here is on their level of awareness of those dimensions. Hence, I have used a generic set of values based on the 'expanding awareness' of or focus on the critical aspect (Åkerlind, 2005b, p. 122) as low, medium and high. That is, the values of all the dimensions in this study are: Low (less aware / in the background); Medium (identified / in the foreground); High (acknowledged / highlighted).

The five dimensions of variation from my study are illustrated below (D1-D5) using participant quotations. Whilst it is impossible to fully illustrate each aspect with small extracts of participant quotations, they go some way to ground the dimensions and categories within the data (Åkerlind, 2005b, p. 124).

D1) Intellectual

Researchers' accounts of using technology were connected to the intellectual and conceptual aspect of research. All participants mentioned the importance of research aims and questions which drove the research stages and processes including the use of technology. In terms of effect and impact of technology use on research, they discussed

the need for discernment and having control over the technology. Some researchers discussed the differences in using technology for quantitative or qualitative research approaches although they agreed that it is generally helpful and could be used for all phases of research. Whether technology use was an integral part of their research, or just an external element and a means to an end, has been a key differentiator. All these discussions indicate a focus on the intellectual aspect of the use of technology.

Quotations below show an expanding awareness or incremental discernment of level of focus on the intellectual dimension of technology use from low to high.

> *I feel as though the thought, ideas, and analysis should come from the researcher, and technology should be a tool to enable that. (Zoe)*

Zoe talks about how the researcher should have control over the technology and conceives the tools to have a lower importance from an intellectual perspective. For her, intellectually, technology use is in the background or has a low focus. The next quotation from Raymond brings the intellectual aspect more to the foreground.

> *… actually knowing that you can, for example, transcribe data a lot quicker these days may influence that you may be able to do more… generate more data than previously you would have done. So, perhaps it has influenced a bit. (Raymond)*

Raymond identifies the role of technology as helping and influencing the research. To him, it enables the researcher to generate more data and its analysis might influence the research. Here the intellectual aspect and the effect on it by using technology is in the foreground and not in the background as in the previous comment. Taking this further Tony, in the next quotation, highlights the intellectual aspect by describing how theory informs his use of technology.

> *… the way I use technology is really I guess informed by the sort of Vygotsky and Marxist way of viewing it is that technology is something that humans use to make something easier but in using that technology they are also affected by it. So the tools we use also have a role in shaping our consciousness. (Tony)*

In this comment, Tony acknowledges the intellectual dimension of technology use by reflecting that his use of technology is informed by Vygotsky and Marxist way of viewing. He highlights how the technology use would shape the intellectual aspects of research.

These quotations illustrate the intellectual dimension of experiencing technology use and the different levels of its discernment. In the first quotation (Zoe) the intellectual aspect of technology use is in the background (low focus), then Raymond's quotation shows its identification or brings it to the foreground (medium focus), and in the final quotation Tony is acknowledging or highlighting it (high focus). Together they show abstract high-level holistic perceptions and thinking with varied focus on intellectual aspects of research. Moreover, research was predominantly seen as an intellectual activity by all participants. Hence it is proposed to be the first critical aspect or dimension of variation in understanding the differences in the technology use experiences. At this point it should be noted that, although presented here in a logical order derived from the data analysis, not all of the dimensions to which the analysis refers to are discerned by each and every researcher or in the exact same order. Neither are all of the dimensions present in every description of their experience of technology use. Next, we move on to a consideration of the process-based dimension.

D2) Process-based

Benefits of using technology for various research processes were noted by all researchers. As referred to in Chapter 5, findings from this study showed a consensus that technology does help, or at least it does not hinder participants' research (Appukuttan, 2015, p. 33). The key benefits in terms of process efficiency included identifying new patterns and relationships in the data, improved speed, higher accuracy and easier calculations. Technology use also helped in extending human capacity in areas such as access to remote locations and data, managing large amounts of data, communication and dissemination, simplifying complexity and providing flexibility in doing various tasks from processing multimedia to even relatively simple tasks of editing and formatting text. The quotations show the incremental level of discernment of the process-based dimension of technology use from low through medium to high. They illuminate the process-based aspect of technology use in research.

> *No no I don't use [NVivo] for analysis; I do my own analysis. (Kate)*
>
> *I am not into fads and fashions. So simply pen and paper is great. … I would clearly use it for word processing. And I would only use an Apple Mac. (Susan)*

While Kate disregards the technology benefits, to some extent, Susan sees technology use as a fashion or unnecessary addition although she would use it where needed and when comfortable to do so. In both cases the process-based aspect has lower focus or is in the background. The next comment from Quin focuses on research as a set of processes, and technology to support that.

> *[The research] starts with questions, what questions have you got, how are they best answered and how could that technology support you. I think, for me technology is very much a support and to drive that. Just because it's there doesn't mean to say I'd get involved in it. (Quin)*

Here, although Quin believes that technology use is driven by the research, she identifies the benefits of technology use in the research processes and brings it to the foreground. Thus, this comment shows a medium focus on the process-based dimension of technology use. In the next quotation, Celine refers to the affordances of technologies and its enabling nature to highlight the process-based nature of usage.

> *I think the ability to search for terms on a word processor, the ability to edit, … and then the tools to enable you to create databases of references … and you know the NVivo software for analysis it's just a tool, doesn't enable you to do anything that you couldn't do. It enables you to work more efficiently faster to do things that you couldn't physically do because you haven't got the time available. (Celine)*

Here Celine clearly acknowledges the benefits of technology use and provides specific examples. She then highlights to what extent and how it helps to improve the efficiency for researchers. This comment shows a higher focus on the process-based aspects of technology use.

Process-based activities and benefits were a significant topic of discussion in all interviews with researchers. Hence, it was the most recognised aspect of technology use by all researchers. These quotations signify this and also illustrate the varied level of focus from low to high.

D3) Contextual

The data showed that technology use is also driven by the context such as research needs, location of research, availability of the right technology, etc. Researchers' experience of

using technology included the constraints of their research, such as whether they had access to technology at home or only at work, whether it had a cost, was free or available through their institution. Another related contextual factor was more development related in terms of what they have been using or had exposure to in their previous research projects. The following quotations illustrate the various levels of contextual relevance to their experience of technology use and are again presented in the incremental level of discernment of the contextual dimension of technology use from low through medium to high.

> *…I think as the current dream of some people that all of the relevant resource material will be put into a technologically accessible form now in the form of digitised material. It won't. Because historians will always be pushing for new materials that aren't accessible digitally. They'll be looking for ways to use that material which isn't possible through the digital presentation. (Nelson)*

> *... PCs [personal computers] were so impossible to understand if you've been brought up on a [Apple] Mac. … I never made a comfortable transition [to Windows], and to this day I'd rather pay more and get a Mac because I feel at home with them…. and a lot of the problems people had in terms of losing things, I never had and therefore I've got a basic trust and so it was my upbringing. (Alice)*

In the first quotation Nelson points out that for some historians, irrespective of the benefits of technology, the research context may not necessarily demand the use of technology. For example, in this case, the digitisation of materials making it widely available results in some historians avoiding them due to its reduced uniqueness for their research. Similarly, in the second quotation, Alice has been so used to using a Mac that regardless of the research project (context) she is unlikely to use a Windows PC. Both of these comments have the context (not their discipline) in the background as they discuss their experience of technology use. The next set of comments focus on the relevant contexts of using technologies.

> *obviously if [a technology is] free… more likely to use it. If it's free or my institution has signed up for it and has a site licence then I am more likely to use it than if I have to pay for it. … the main factor for me is the thing I'm trying to do and how it aligns with that. (Tony)*

> *I'm not using it at the moment, I don't have access to it at home. When I did have access to it I thought it was brilliant, except I had slight trouble in getting it to format Harvard properly. (Alice)*

Tony relates the usage to the contexts of cost as well as its alignment with his research. In effect, he talks about the access to technology context as a factor. Alice also identifies this factor in terms of location. Like many of the participants of this study she also does some of her research at home, and not having the same institutional technology access at home has an effect on what technologies she was able to use. Both of these comments bring the context to the foreground when describing their experience of technology use. Taking this further Quin acknowledges the contextual aspect more specifically and highlights it with an example.

> *I suppose [theory] does have an impact because if you are going from this feminist point of view where you regard research as a much more collaborative enterprise between yourselves and the participants, then you wouldn't just go along and say 'yeah right, we are going to use Skype for the interviews'… you would may be... give a choice. (Quin)*

In Quin's case the theoretical position has a bearing on methods and hence the appropriateness of relevant tools that she would use. This is an example of contextual dimension described in a higher level.

For the research participants, the discernment of technology use was primarily associated with their research aims and driven by the context. Thus their descriptions of technology usage and experience always had, covertly or overtly, an element of context as a rational for their actions.

D4) Emotional

Chapter 4 discussed researchers' experience of doing research and identified emotion as one of the themes described by the researchers. It used Åkerlind's range: anxiety to satisfaction, frustration and joy, interest and enthusiasm, 'passionate engagement', to illustrate the variations (see Table 3). Similarly, the following discussion focuses on the emotional aspect of using technology rather than doing research. Åkerlind's range of emotions of researching were also evident in the technology use context. However, further analysis showed that emotion in technology use is driven by two key elements: 1) level of understanding or exposure to the affordances of technology used, and 2) the occasions where the technology did or did not behave as expected. The positive emotions were often

in the background, unrecognised, or taken for granted. Regardless, there were plenty of occasions where the researchers described the emotional issues with varying levels.

> *… with me it's not technology phobia, it's just literally I just don't ever seem to get the time to sit down and really engage with it. And when I do, I learn the mechanics of it, I think what we got to do is get going and do something. But because I never feel that I've got anything really to do with it, then I slip back again. (Quin)*

This comment shows limited drive and passion and provides reason for lack of engagement with the use of technology. Quin feels less emotionally charged with the level of effort and success associated with it. In other words, the emotional aspect of technology use is in the background or low. However, in the following comments emotions of frustration and fear are evident.

> *… there are frustrations if you know you can't get it or it goes slow or anything like that. And setting it up, like setting up the website is quite fiddly. But the first time you do anything is quite difficult to be honest. (Kate)*

> *I expect it to be our servant rather than becoming our master, and I do fear that a whole variety of forces potentially see technology as being a structure which I think might become constraining. If I'm restricted to looking at material which others have chosen to make available through a particular technology then that will limit my capacity to develop new knowledge. (Nelson)*

Unlike Quin, Kate shows frustration when things do not work as expected. Although she identifies and brings her emotions to the foreground, she is able to set them aside and persevere. However, Nelson is concerned about the constraining effect technology use could have on his research. The fear is that another researcher's or person's choices in terms of technology facilitation could become detrimental to his contribution to new knowledge. Both Quin and Nelson identify the emotional aspect (e.g. frustration, fear, etc.) of their technology use and bring it to the foreground. In this next comment Tony shows high level of emotions:

> *… when the technology doesn't work or you know when there are deliberate things… so… for example one of the annoying thing would be with [a specific CAQDAS software] if you analyse something on … say [version 4], and if you try and open [it] in [older] version [3] it won't even let you open it. It is just a complete commercial thing. So that you have to buy a new one. Things like that just really irritates me when I am trying to get things done quickly. (Tony)*

Tony is clearly feeling frustrated. This is evidence of a combination of the elements 1 and 2 that drive emotions, that is, understanding of affordances and technology not behaving as expected. He is really annoyed and blames the commercial practices of the technology providers, which he characterises as placing profit above user-experience. His description highlights the emotional aspects of technology use.

The previous three dimensions of variation of technology use (Intellectual, Process-based, and Contextual) focused specifically on the act of researching. The Emotional dimension here, however, shifts the focus towards the researcher. It also had varying levels of presence from low, medium to high in the researcher's experience of technology use. Although there were some elements of technophobia among the descriptions, researchers' emotional experiences were more strongly focused on the negative experience of engaging with technology than positive. This is an important and interesting dimension that warrants further investigation in relation to technology adoption by researchers. In addition, it appeared that, persistent exposure and use of technology changed some of these to more neutral emotions or switching towards a positive direction (see comment from Edwin in the previous chapter on page 114). Thus, in many senses, emotional dimension is an important aspect and hence selected as the fourth one.

D5) Developmental

Different levels of skills required for the effective use of technology was evident in all participant researchers' descriptions of their experiences. Although they were aware of such issues their views on the investment needed for developing such technical skills were varied. Some saw technical skills development as part of their research skills whilst others saw it as an additional development need that is external and independent of their research. As Susan asserts below some researchers do not see development as something worth investing their time in.

> *… there is getting up to speed with it, and learning it, and there is the danger that you think it's more efficacious than it really is and you waste a lot of time dealing with software when you can actually deal with it better with old fashioned pencil and paper. Sometimes it doesn't work. It is expensive. The University is constantly upgrading it, etc. etc. (Susan)*

Susan points out to one of the ways she experiences the use of technology – a worthless huge investment of time, only to be in vain because of factors such as expectations on the efficiency gain, cost, technical issues, and constantly evolving nature of technology. Hence, the development aspect is in the background or is of lower focus for Susan (and many other researchers too). Although the comment sounds pejorative of technology's value to research, this study found that development has high significance as seen in Chapter 5 and is discussed further in Chapter 7. For example, Quin describes her experience of attending technology training in a positive way and shows how she welcomes developing her technological skills. This brings the development aspect to the foreground of the experience of technology use:

> *It's like they will deliver training and I'll go on it, cos I'll think oh that might be useful. And then you don't embed it, it doesn't become embedded in practice, and then you forget about it. And then it's like oh, I need to go for another one now. (Quin)*

This issue of forgetting the training due to learning things before they actually need it in practice was shared by many other participants. Quin identifies the need for embedding the technology skills developed in her research practice and realises that otherwise she will forget about it and may have to redo the training. Thus, for Quin, the development aspect has a medium focus or is in the foreground. Whereas comments from Raymond and Alice below show how they take development more seriously.

> *… in order to use these kind of technologies people have to be trained and have to give up some time to understand how to use them. And to some people that is a drawback when they are pushed for time. (Raymond)*

> *Yeah it needs to be a person that can explain it in a way I can understand when I need it. Paper based is (slap on the table) no use to me, I can't understand what it's on about or… online. It needs to be a human being. (Alice)*

Raymond acknowledges the relevance of training and the need to commit time. He goes further and also highlights the challenges some researchers might experience in terms of finding the time for development. Alice also acknowledges the development needs and highlights further details such as the type of training she prefers; that is face-to-face than paper based or online. Together, these two comments highlight the complexity of the development aspect such as training needs, their medium or types of training, autonomous

or assisted learning. They demonstrate the importance of developmental needs and its level of awareness among researchers. Hence, developmental is the fifth dimension or critical aspect in understanding researchers experience of technology use.

The sections above systematically presented the five critical aspects or dimensions of variations: D1) Intellectual, D2) Process-based, D3) Contextual, D4) Emotional, and D5) Developmental. Mapping these variations with researchers' experiences show that the first four dimensions (D1 - D4) closely related to researchers' experiences of conducting research (discussed in Chapter 4) and the fifth one (developmental) to the use of technology (discussed in Chapter 5). This made sense as my participants were experienced in conducting research and did not see it as an area where they needed much development in particular. However, use of technology was a relatively new and less embedded element within their research experience, and hence development was often part of their discussions of technology use. Hence it was designated as the fifth critical dimension. Whilst these were not the only aspects, they were the most dominant ones based on the phenomenographic analysis. The next section discusses the categories of descriptions in relation to these dimensions of variation.

Categories of descriptions

As referred in the methodology chapter, 'categories of descriptions' can also be seen as referential aspects which provide a meaning in terms of how it is referred to in a context. An experience might have a distinct grouping of aspects or dimensions. Different descriptions of experiences can be examined to identify varied groupings and form various categories of descriptions. Prosser et al. (2005, p. 151) clarifies that categories do not provide rich descriptions of individual experiences or the full possible variations but describes the variation in the key ways in which the experiences of the phenomena may differ. In other words, categories are varied ways of representing a phenomenon rather than individuals.

At a given point, an individual experiences a phenomenon in a partial way. The researcher groups this with other similar accounts of experiences and interprets it as a category of a collective experience. Marton and Booth (1997, p. 128) suggest that a way of experiencing is never more than part of the phenomenon experienced. It should be noted that

statements of a 'way of experiencing' is a particular individual's awareness level of the phenomenon whereas 'categories of descriptions' are the researcher's (my) groupings of qualitatively different ways of experiences of the collective, derived from the reports or inferences of the participants (Marton & Booth, 1997, pp. 127–128).

There are three criteria for validating the categories of descriptions: first, each category must tell about a distinct way of experiencing; second, the categories should have a logical (often hierarchical) relationship to one another; and third, the critical variation in the data should be captured into parsimonious number of categories (Marton & Booth, 1997, p. 125). These criteria are applied to participant researchers' experience of technology use to develop categories of descriptions.

Analysis of the interview transcripts initially identified five categories of experiences in terms of expanding awareness of technology use as: Irrelevant, Secondary, Integral, Informing and Technology led. However, further rounds of analysis found similarities between the last two categories of Informing and Technology led. In addition, from the data, it was established that researchers saw technology as something that has no agency of its own and researchers will always make the final decisions (see Appendix 6 for audit trails of developing Categories and Dimensions). To that effect, it was decided to only use four categories. Some phenomenographic studies have used longer descriptive category names; however, for ease of reference I have used short labels similar to Bowden et al. (2005, p. 130). For the purpose of clarity, a descriptive text is also included where applicable.

Categories → ↓ Dimensions	***C1) IRRELEVANT***	***C2) SECONDARY***	***C3) INTEGRAL***	***C4) INFORMING***
D1) Intellectual	Low	Low	Medium	High
D2) Process-based	Low	Medium	High	High
D3) Contextual	Low	Medium	High	High
D4) Emotional	Low	Low	Medium	Medium
D5) Developmental	Low	Low	Medium	High

Table 4: Outline structure of categories

The next section will discuss each of the categories of experience. An outline structure of the categories and dimensions are presented in Table 4. Each column represents a

category of experience (C1-C4), and the rows represent values (low, medium and high focus) for each of the dimensions (D1-D5). Each category will be illustrated using participant quotations referring to the relevant dimensions. The final structure is presented at the end of this discussion.

At this point it should be noted that the categorisation is based on my interpretation of the data. Ashwin asserts that:

> … it is accepted that it is not the only possible outcome that could be developed from the data. What is important is that the categories can be argued for convincingly on the basis of the data. … it should also be noted that it is the variation between the categories, rather than the categories themselves, that are the focus in phenomenography, and thus it is the differences between the quotations in the different sections that should be examined and questioned (Ashwin, 2006, p. 655)

Thus, it is acknowledged that the data could be interpreted in other ways to formulate different sets of categories than presented below. Hence, each category will be introduced using quotations to demonstrate the variation in terms of its referential meaning. Then the structure of the meaning will be discussed based on the extent to which the five dimensions (D1 to D5) are present in the background (low focus), foreground (medium focus), or highlighted (high focus). As referred to in the theoretical framework of this thesis (see Figure 7 'Gurwitsch's Structure of awareness' in Chapter 3), the structure of these categories constitutes of the combinations of dimensions D1 – D5 that are currently in the theme or internal horizon; as well as the dimensions that are currently in the thematic field (and margin) or external horizon (Marton & Booth, 1997, p. 136).

C1) Irrelevant (technology use is in the background)

Many researchers do not notice technology use as a phenomenon among the plethora of research issues. However, ontologically, whether or not the researcher focuses on the technology use, the use still exists and plays a role in their research. Comments below show that technology use is not necessarily in focus but is evidently present in the background of their experiences. They are presented in the order of their level of technology use from mostly rejecting to hidden appreciation.

I think research can't, research shouldn't… sorry ICT shouldn't be even substitute for the traditional methods. You know it's still important to have that contact with people. I think that is quite key (Megan)

In this comment Megan is apprehensive about technology use and experiences it as something that might substitute traditional methods and argues for a lower relevance. From the perspective of dimensions of variations discussed earlier in this chapter, none of the dimensions are in focus. In other words, the critical aspects are in the background or thematic field which is part of the external horizon. If at all there is a reference, it could be Process-based dimension (D2) referring to the methods, and that too not in the foreground. In this next description, Don does not fully reject the use of technology.

I'm not very computer literate person. So if I have to avoid technology I would do, so I think it's… I'm not a digitally native person. I mean when I was growing up technology wasn't actually around so I think, when it comes to technology it doesn't come naturally to me as in, as if the way it might actually come naturally to my son or my daughter. (Don)

Don mentions about the developmental dimension and points to not being someone at ease within digital environments as the reason for his limited usage. Hence he relates to an unnatural effort required in using technology in his research. Dimensions wise, there is the emotional and developmental aspects that are in the background in terms of childhood experience and perceived skills development barriers. However, Zoe below is not concerned about technical skills (developmental dimension) but her concern is whether using technology would have unnecessary effect on her research.

well certainly for me it wasn't the difficulty of using the technology it was the fact that I felt that the data I had really needed the researcher to be the interpreter and analyst rather than it to be an automated process. (Zoe)

Zoe experiences technology use as an automated process that researchers may not have much control on and hence ascribes low focus to it. This concern, of technology starting to interpret, shows the Intellectual dimension in the background in terms of the effect it could have on her research. The developmental aspect, in terms of difficulty or ease of use, and the emotional and contextual aspect as in the feelings about the suitability of technology usage in this particular context are also in the background. She also mentions automated process referring to the process-based aspect of technology use. Thus, we can see elements of all dimensions in this comment but they remain in the background.

Heather talks about publications and engaging with wider communities which were typical conversations within the data.

> *I don't think being a researcher is just about how many publications we can generate anymore. I think we need to do much more than that. And I actually really engage more with our wider communities, something that I'm very interested in and very passionate about the whole idea that we engage with communities; we don't keep academic knowledge for ourselves in the academic community. We share it. (Heather)*

Here the intellectual dimension is present as in production of knowledge and process-based dimension as in the activities involved in producing, engaging and sharing the knowledge. Emotional and contextual aspects are also present when discussing about passionate engagement. However, it must be said that although technology use will be part of doing research it is not clear whether those dimensions really transcend towards the technology use or just part of their researcher identity. What is evident is that all the activities mentioned in this comment generally would involve the use of one or more technologies but they are well hidden in the background.

These quotations present the case of hidden or passive ways of experiencing technology use in their research. Although technology use plays a role in the activities referred in the quotations, they appear to be in the background or are seen as irrelevant. However, when probed specifically about their technology use, these participants responded with the same contexts as examples as shown in the later categories. This shows researchers may not necessarily highlight their technology use in their research activities and might unintentionally or unconsciously ignore it. Thus, although technology use is not in focus, it was evidently present as part of their experiences. In other words, there were plenty of concealed or hidden acknowledgements of technology use. That is, in this category all of the five dimensions identified will have lower focus or will be in the background of their awareness. Which implies, in the Category 1 of experiences or conceptions, technology use is not in focus or relevant but ontologically it still existed in the background.

In phenomenography, conception is the unit of description and it has two intertwined aspects: referential and structural. The former "denotes the global meaning of the object conceptualized" and the latter "shows the specific combination of features that have been

discerned and focused on" (Marton & Pong, 2005, p. 335). Here in this category, the referential aspect is 'technology as irrelevant' and the structural aspect is the specific combination of features of the dimensions D1 to D5 all of which have the value 'low'. This structure can be illustrated diagrammatically. In her study, Åkerlind had used a table to illustate this strcuture and she explaines that:

> I use tables because they provide a simple visual outline of the hierarchical relationships between categories, in terms of the increasing complexity or breadth of awareness across categories. They also allow a holistic perspective on collective experience of the phenomenon, illustrating the variation within the whole. (Åkerlind, 2005b, p. 125)

Adapting Åkerlind's approach, Table 5 summarises the structure of this category and all dimensions are seen in red as of low relevance (less aware or in the background). Mapping this to 'Gurwitsch's Structure of awareness', here all five critical aspects (D1 to D5) are in the thematic field or external horizon, and none are in the theme or internal horizon of the structure of awareness.

CATEGORIES → *(experience of technology-use)* ↓ Dimensions	***C1) IRRELEVANT*** Not aware or in focus
D1) Intellectual	Low (less aware / in the background)
D2) Process-based	Low (less aware / in the background)
D3) Contextual	Low (less aware / in the background)
D4) Emotional	Low (less aware / in the background)
D5) Developmental	Low (less aware / in the background)

Table 5: Structure of Category C1) Irrelevant

Whilst a researcher's experiences of technology use might be subjective to that researcher, in the real world, the effect could be evident to someone else. Whether or not the researcher focuses on or is aware of it, the technology use still exists. Hence it is worth

proposing this Category 1 'Irrelevant' as the first one which has the lowest level of technology use awareness compared to the rest of the categories discussed later.

In summary, descriptions of experiences in this category would have references to technology use in terms of their dimensions of variations in the background or as if it is not relevant. Researchers' awareness of technology use would appear as ignored due to inexperience. Here the position of technology use is external to the research and its role is to be led by the research objectives. Researchers are not concerned about their control on the technology as the control is assumed.

C2) Secondary (technology use is research led)

From the analysis, technology use as 'Secondary' was identified as the next prominent way of describing it. Although they had experienced technology differently at different times, all participants were strong on the view that research and its aims should and will lead all related aspects of that research. Hence, technology use will always be driven by the research. Such experiences were also explained as technology is always controlled by the researcher – a human. There was a general consensus among participants that technology does not have agency; it has to be instructed by the researcher. The quotations below are presented in the order of evidences provided for the rationale of experiencing technology use as Secondary. The first quotation is more of a generalisation whereas the last one gives examples of human dominance in each research activity to illustrate the secondary nature of technology use.

The following quotations show the beginning of departure from the Category Irrelevant (C1) experience horizon:

> *In the end research is based on good intellectual work. And all the technology is a tool to enable you to do it. ...the main drawback is people who think that the technology is the research; and it's not. But you know, it is a tool. A pen and a pencil is a tool, that's all that technology is. (Susan)*

Here Susan insists that technology use is always going to be secondary as it is just a tool; a means to an end. The hidden view in this statement is that it is not necessarily irrelevant but there is some benefit in using technology. The focus here is around the process-based

aspect of technology use because it is compared with a passive tool such as pen and paper. It can be seen as having less connection with research, and probably positioned externally to their awareness. Dimensions other than Process-based (D2) are not really present in this comment or are in the background.

Compared to Susan's view, Quin identifies the relevance of technology but emphasises that it does not have to be used in all situations. That decision is made by the human – the researcher:

> *We can't pretend that technology doesn't exist and we can't automatically assume it has no relevance. By the same token, we can't automatically assume that it does have relevance, that all technologies can be useful in all situations. …This is where us as human beings use our intelligence to make decisions about the menu of things that are available to us. (Quin)*

Here one of the dimensions is process-based as participants often associated it with usefulness, efficiency, etc. It also mentions the contextual aspect by saying that the assumption of relevance of technology use is not automatic; in other words, its use depends on the research context. Quin also mentions the intellectual dimension but links it with humans' decision making; hence it can be interpreted as implying a lower intellectual relevance for the technology use. Thus, the two aspects here in focus or foreground are Process-based (D2) and Contextual (D3). Zoe's comment below clarifies Quin's assertion of relevance of technology by providing it a space in her research by saying that it is a platform but still sees it as secondary.

> *I think the technology is only a sort of a platform, almost a substrate if you like, that you use to organise thoughts on. So the extent to which you use it, you know whether you use a full blown analysis package like NVivo, or whether you just use it to organise your thoughts in your own way. I think the analysis should still remain with the researcher. I'm just using technology, as I say, the tool for using that. (Zoe)*

Similar to Quin, Zoe also argues that technology is just a tool and reiterates its substrate nature of technology use. She expands on Quin's point about the role of human intervention by locating the analytical stage of research as an example and thus focuses on the Contextual dimension (D3). She also seems to use technology for analysis as a tool to organise her thoughts. Here Zoe does not focus on how technology use benefits her thought process and pushes the intellectual (D1) dimension to the background. Instead, the

focus is on the activity of organising, that is, the Process-based (D2) dimension. The other three dimensions are not present in this quotation.

The next quotation explains this category of experience in a bit more detail.

> *…[The qualitative data analysis software] has helped me look at a reasonably large data set and has helped me to see patterns. But I had to record what the patterns were, it was I as the researcher was saying - I'm going to file that there and put that there … Or it was I as the researcher who was saying - well these are the key words …where are they. So I think that the agency of the researcher is still completely apparent… data needs to be interpreted and ultimately that is a human job. (Ben)*

Ben's comment amplifies what Quin and Zoe suggested in relation to human intervention, in terms of what patterns to record, what keywords to use, how to structure the analysis, etc. He states the lack of agency of technology and confirms that, regardless of the technology use, it is the researcher who interprets the data. This comment also focuses on a specific situation and thus brings it to the foreground and clearly emphasises on the Contextual aspects (D3) by saying how it helped the process of looking at a large data set to see patterns. This could also be seen as Intellectual (D1) as it is helping the thinking however, Ben credits it solely to the human agency and pushes the intellectual dimension to the background.

Closer examination of these quotations shows that researchers experience technology use as secondary or led by research, and hence it is named as Secondary (C2). The analysis above also suggests that such experiences are likely to foreground the dimensions Process-based (D2) and Contextual (D3) while keeping the other three dimensions in the background. Table 6 summarises the structure of this category where D2 and D3 dimensions are in amber colour as having medium relevance (identified / in the foreground). This means the category 'Secondary' (C2) differs from 'Irrelevant' (C1) in that the two critical aspects (D2 and D3) are beginning to come to the centre of awareness structure, that is, the 'theme' or internal horizon while the rest of the three critical aspects (D1, D4, and D5) are still in the thematic field or external horizon.

Here the researchers experience use of technology as an external means to an end, but still under their control. Category 2 shows how researchers' experience of technology use

aligns with the axioms of technology as an enabler, and extends to argue that technology can only do what the humans (researchers in this case) ask it to do. However, this second point can be contested in the later categories of experiences.

CATEGORIES → *(experience of technology-use)* ↓ Dimensions	***C1) IRRELEVANT*** Not aware or in focus	***C2) SECONDARY*** An external means to an end, controlled by researcher
D1) Intellectual	Low (less aware / in the background)	Low (less aware / in the background)
D2) Process-based	Low (less aware / in the background)	Medium (identified / in the foreground)
D3) Contextual	Low (less aware / in the background)	Medium (identified / in the foreground)
D4) Emotional	Low (less aware / in the background)	Low (less aware / in the background)
D5) Developmental	Low (less aware / in the background)	Low (less aware / in the background)

Table 6: Structure of Category C2) Secondary (with C1)

In summary, descriptions of experiences in this category would have two critical aspects of technology use in focus: Process-based (D2) and Contextual (D3). Researchers' awareness of technology use would appear as consciously ignored. Similar to previous category C1, here the position of technology use is external to the research and its role is only to be led by the research objectives. However, in this category, researchers describe their need to control the technology due to the concerns of its effect on their research and see technology use as an external means to an end.

C3) Integral (technology use is embedded)

A holistic view of research and technology use is evident in this category of experience. The technology use is not seen as separate from all the other research related aspects. In this category, researchers felt more confident and in control when discerning technology use. This is the first shift to positive and inclusive attitude towards technology use as compared to categories Irrelevant (C1) and Secondary (C2). Researchers are equally open to using technology as well as not using it. Since it is embedded in the activities and has

overall benefits they are less concerned about the effects it could have on their research. The quotations below are presented in the order of level of integration from passive to active embedding of technology use within their research. The first quotation below shows a generic open approach to the integral role of technology use where the researcher is clear what they want the technology to do. In the final quotation the researcher is beginning to give credit to the technology use although still within human control.

Tony shows how technology is an integral part of his research activities.

> *… what I will do is I would work out the thing I need to do, find out what I need to support it, then have a go at it with some people I trust where it doesn't matter if it all goes wrong. … There are things that I want to do in research and there are technologies that I use to help me to do that. So for the things mentioned before using networks, or for having Skype conversation with people, I use email to develop those networks, use technology to access the literature, use software to analyse my data, so in a way I don't view technology as something separate. It's an integral part of what I do. (Tony)*

Tony uses the technologies with clarity and discernment in terms of knowing what technology to use to achieve his relevant activities. He identifies the learning required and his approaches refer to the Developmental dimension (D5). The process aspect of technology use is also clearly highlighted and provides specific examples along with the contexts where they are used. So the Process-based (D2) and Contextual dimensions (D3) are acknowledged. There is no hint of emotional aspect in this comment. Since he does not see technology use as secondary or irrelevant, but as part of the research, the description can be interpreted as referring to the Intellectual dimension (D1), albeit not as highlighted as D2 and D3.

Xavier says that if it is the right tool he will find the funding to source it because it is crucial to his research.

> *Sometimes that particular software may not be available… May not have the licence at the University. …The point is whether it is available or not is fully a secondary. […] if I feel that a particular software or a technique that is the right one then I make my own effort... [use] fund from university or my own research fund and try to make it available. (Xavier)*

Here the Process-based (D2) and Contextual (D3) dimensions are evident from the emphasis of it being the right one for the right context. The determination exudes the

passion and shows Emotional dimension (D4) although again not as high as D2 and D3. In essence, this comment shows how the technology use can be such an integral part that the researcher could go to great trouble to make it happen.

Susan shows the range of ways technology use can help in various research processes and contexts without which the whole research will not be the same.

> *I think technology has got a number of ways… one is clearly it can help with writing, clearly it can help with communication, clearly it can help with capturing data, whether that is visual data or audio data. It can also help in other ways things like… you could give children for example a camera and say go and photograph parts of the school you think you learned the best. So the children can use different kinds of technologies if you like to collect different types of data. (Susan)*

Susan starts by highlighting the Process-based aspect such as writing, communication, and capturing data. It also highlights technology in a specific context (children capturing data using camera). In addition, the camera used by children cannot be removed from the research as it is a data generation instrument and part of conceptual definition of the research. Although not highlighted it brings the Intellectual dimension (D1) of that research to the foreground. This comment also provides specific examples and highlights the Process-based (D2) and Contextual (D3) dimensions and how much it is intertwined with the research. In summary, Susan's comment shows the efficiency gain and enhancements brought by technology to their research especially in specific situations and contexts.

Quin demonstrates how technology is already the norm in research contexts that use quantitative approaches (contextual aspect).

> *I mean now SPSS has, I would think, revolutionised quantitative research. Can you imagine when you have to do all those sums… now you just put the values in and everything is done. Even I've used SPSS in the past. […] I would still say that I don't think technology can do the research because it's not a living, it's not got natural intelligence has it? The intelligence is super imposed… but you've got to decide how that goes. (Quin)*

Quin begins to give credit to the technology and refers to how SPSS is helping the researcher by presenting calculated results (Process-based) for the researcher to make decisions (Intellectual). Although Intellectual dimension (D1) is in the foreground the comment highlights Process-based (D2) and Contextual (D3) dimensions. However, the

key is to understand the affordances of the technology and be able to discern the right one for their research.

The analysis above also suggests that, although they are not referred in each quotation explicitly, all of the dimensions of variations are coming out of the background to foreground or even highlighted. In the case of Process-based (D2) and Contextual (D3) they are clearly acknowledged and are highlighted with examples. Table 7 summarises the structure of this category where D2 and D3 dimensions are coloured in green as having high relevance (acknowledged / highlighted) and the other three in amber as medium (identified / in the foreground). Here Integral category (C3) differs from Secondary (C2) in that all the five dimensions are in the 'theme' or internal horizon of the awareness structure. In addition, the two critical aspects (D2 and D3) are not only in the theme but also highlighted within the participant descriptions.

CATEGORIES → *(experience of technology-use)* ↓ Dimensions	***C1) IRRELEVANT*** Not aware or in focus	***C2) SECONDARY*** An external means to an end, controlled by researcher	***C3) INTEGRAL*** Consciously seeing research and technology use as not separate but integral, intertwined and embedded in research
D1) Intellectual	Low (less aware / in the background)	Low (less aware / in the background)	Medium (identified / in the foreground)
D2) Process-based	Low (less aware / in the background)	Medium (identified / in the foreground)	High (acknowledged / highlighted)
D3) Contextual	Low (less aware / in the background)	Medium (identified / in the foreground)	High (acknowledged / highlighted)
D4) Emotional	Low (less aware / in the background)	Low (less aware / in the background)	Medium (identified / in the foreground)
D5) Developmental	Low (less aware / in the background)	Low (less aware / in the background)	Medium (identified / in the foreground)

Table 7: Structure of Category C3) Integral (with C1 and C2)

In the quotations above, Tony, Xavier and Quin in particular demonstrate the need for the right level of agency from the researcher in terms of their discernment in choosing the right tool rather than trying to overpower and control the technology as in the experiences of the previous category Secondary (C2). These quotations show the level of confidence in using technology (for example, Tony saying "it doesn't matter if it all goes wrong") and awareness

of its affordances (for example, Quin's understanding of SPSS). Although this may not mean that they are technically skilled or are an evangelist, the key conception in this category is that researchers experience research and technology use as not separate but integral, intertwined and embedded in research.

In summary, descriptions of experiences in this category would have all critical aspects in focus although two of them are highlighted: Process-based (D2) and Contextual (D3). Researchers' awareness of technology use would appear as in focus although not necessarily intentionally. Unlike the previous categories C1 and C2, here the position of technology use is internal or part of the research and has a complementing role. Here researchers are not concerned about the control on technology but rather it is about discerning the right technology for their research. In essence, the technology use is intertwined with research and is embedded in it.

C4) Informing (technology use is complementing)

This final category advances from the previous categories in terms of researchers sharing experiences of technology use that contributes to the development of their research in a complementing, informing or even defining way. Technology can surprise researchers by providing wider choices and encourage them to choose new insights for their research. The quotations below are presented in the order of effect on research and relevance of development. They show how technology use would shape the research and the researcher's approaches, and cautions about such effects. Skills development is highlighted as important to make those effects more intentional although the need for specialist development and support could go beyond what is available within their own institution. It goes on to highlight what researchers could be missing if the technology use is ignored completely.

Tony describes how technology use could be seen as shaping his research.

> *…what I am trying to do and what I'd like using technology for, particularly something like SPSS, is it allows you to think about the structure of the dataset as well as the individual parts of it…. for me, is that ability of technology to far more easily give you the sense of an overall structure of… a large dataset... in that sense it shapes it. (Tony)*

Here technology use is enabling Tony to analyse larger data sets more easily (highlights Process-based aspect – D2) and getting an overall structure as well as individual parts of the data. In that sense he feels that it shapes his research which highlights the Intellectual aspect (D1). Also, in this particular case, he is interested in the structure of the data and hence using the affordances of SPSS which highlights selection of technology use based on the Contextual aspect (D3). This level of experiencing technology will come from Emotional (D4) and Developmental (D5) investment in terms of technology use although they are not evident in this comment. These dimensions are present in this next comment which shows the complementing or somewhat defining ways that technology use has changed the nature of the researcher's engagement with research.

> *It changed the nature of my engagement with the wider body of knowledge and work. … it has allowed me to do types of research otherwise I haven't been able to do before. So, for example, have just done a piece of work which has been analysing school websites; that wouldn't be there without the technology to support the website. So I suppose, I see technology generally in a very positive way and in relation to research facilitating new types of research, and also allowing research tasks, you know, to be done more efficiently. (Ursula)*

Ursula above had recognised that it facilitates research that she would not have been able to do without the help of technology, or if not, in an efficient way. It refers to engagement with the body of knowledge (Intellectual), technology helping to do more efficiently (Process-based) and enabling specific research about websites (Contextual). The three dimensions D1, D2, and D3 are clearly highlighted here. Overall it projects the enthusiasm and excitement of technology benefits and hence the Emotional dimension (D4) is also in the foreground.

The comment from Raymond below clearly shows the informing category of experience however, it comes with some caution.

> *You have to understand the technology and how it works. And you also have to be trained to use it. Using something like NVivo, if you're not careful it can start to make you think about data in certain ways. You need to think about what you're doing with it. (Raymond)*

Raymond points out that researchers have to understand the affordances of technology and how it works (Process-based) and highlights the importance of training (Developmental). At the same time, he also warns that researchers should understand the

effect technology use could have on their research (Intellectual) and the need to consider what they are really doing with it (Contextual). In addition, Raymond also shows some passion by insisting that researchers "have to…", "if you're not careful…", "need to…", etc. when thinking about their approaches of technology use which brings the Emotional dimension (D4) to the foreground.

Finally, Ben goes a step further and points out the potentials of technology use.

> *As far as researchers are concerned, … I am a … quantitative researcher but too often I have heard social scientist saying something along the lines of 'numbers can't explain the world', or you know 'it's people's perceptions or the multiple realities', and I would have said those things, but now I'm thinking, well ok but that means you are missing out on a huge amount of information that would inform your qualitative research. (Ben)*

Ben passionately argues that technology can inform research (Intellectual) beyond number crunching (Process-based). For example, analysing a large data set using technology in one particular research (Contextual) can reveal key insights that would inform another research or pose new research questions. He also says that "…I would have said those things, but now I'm thinking, …" pointing to the changed awareness of what technology use can do (Developmental). An Emotional dimension (D4) is also in the foreground when he warns that by rejecting technology affordances some researchers could be missing out.

Although all dimensions are not referred in each quotation explicitly, a closer examination suggests that most of the dimensions of variations are acknowledged or highlighted. Since they are aware of and open to the effect of technology use, emotionally they are not necessarily explicit in every case. Hence while all dimensions D1 to D5 can be high the Emotional aspect (D4) does not have to be. Table 8 summarises the structure of this category where all dimensions are in green colour as having high relevance (acknowledged / highlighted) except Emotional aspect as medium (identified / in the foreground). In other words, in this category, similar to Integral (C3) all the dimensions are in the theme or internal horizon. The difference with C3 is that all except emotional aspect (D4) are highlighted.

In this category, researchers would experience technology use as developments that can complement, inform or define research. Comments above from Ursula and Tony show that

researchers and their research can be shaped by technology use. Raymond highlights the significance of development needs experienced by researchers in this category. The key message for this category can be interpreted from Ben's comment as how researchers should see technology use as an informing phenomenon than just effecting their research.

CATEGORIES → *(experience of technology-use)* ↓ Dimensions	***C1) IRRELEVANT*** Not aware or in focus	***C2) SECONDARY*** An external means to an end, controlled by researcher	***C3) INTEGRAL*** Consciously seeing research and technology use as not separate but integral, intertwined and embedded in research	***C4) INFORMING*** Developments that can complement, inform or define research
D1) Intellectual	Low (less aware / in the background)	Low (less aware / in the background)	Medium (identified / in the foreground)	High (acknowledged / highlighted)
D2) Process-based	Low (less aware / in the background)	Medium (identified / in the foreground)	High (acknowledged / highlighted)	High (acknowledged / highlighted)
D3) Contextual	Low (less aware / in the background)	Medium (identified / in the foreground)	High (acknowledged / highlighted)	High (acknowledged / highlighted)
D4) Emotional	Low (less aware / in the background)	Low (less aware / in the background)	Medium (identified / in the foreground)	Medium (identified / in the foreground)
D5) Developmental	Low (less aware / in the background)	Low (less aware / in the background)	Medium (identified / in the foreground)	High (acknowledged / highlighted)

Table 8: Structure of Category C4) Informing (with C1, C2 and C3)

In summary, descriptions of experiences in this category would have all critical aspects in focus and highlighted except the Emotional aspect (D4). Researchers' awareness of technology use would appear in focus and intentional. Similar to the previous category C3, here the position of technology use is internal or part of the research and has a complementing role. Here researchers are open to experimenting and would only have a limited control on technology and could also result in an investment in terms of skills development. It might even be possible that these developments can complement, inform or define their research. The next section brings the dimensions and categories together as an outcome space which is a key outcome of phenomenographic approach.

Outcome space

Outcome space is an interpretation of the researcher employing the phenomenographic approach, and is based on the data and findings. Marton and Booth (1997, p. 125) define it as "the complex of categories of description comprising distinct groupings of aspects of the

phenomenon and the relationships between them". Outcome space can be constituted with a priority given to the logical structure, or empirical evidence grounded in the transcript data (Åkerlind, 2005b, p. 118). The first approach could propose a more logically structured outcome space and can be justified because the "inadequacies in the data may mask, or not highlight, structural relationships" while the second approach is based more on the data, and seen as "reducing the potential for researcher prejudice by encouraging the researcher to stay as faithful as possible to the data" (Åkerlind, 2005b, p. 118). Åkerlind had given equal weight to both approaches and I followed her lead. My analysis started with the search for holistic meaning (to form categories of descriptions) including its commonalities and differences. Then alternated the focus of analysis between both meaning and structure (to form dimensions of variations) in constituting the outcome space while ensuring that the findings and outcome space proposed is confirmed by the data (Åkerlind, 2005b, p. 119). In addition, similar to Åkerlind's approach, low, medium and high were used as 'themes of expanding awareness' in representing structural groupings of dimensions of variation, clarifying the structural relationships between different dimensions (Åkerlind, 2005b, p. 122). Consequently, the categories are organised below with regard to their logical relations in terms of the dimensions of variations to form an outcome space (Marton & Pong, 2005, p. 335). It shows the four categories in terms of developing awareness of the relevance of technology use in research, and the focus (or lack of it) on the level (low, medium or high) of the five dimensions in each category.

In essence the outcome space (see Figure 12) shows a shift from predominant focus on research activity alone to a combined focus on research and technology use as it goes to higher categories. The concentric circles show the horizons or edges of categories C1 to C4. The four straight lines divide the circles (categories) into five dimensions of variations from D1 to D5. As the legend in the lower part of the figure under 'Discernment level of dimension' suggests, the colours red, amber and green represent the level of focus on those dimension in each of the categories as low, medium and high respectively. This is identical to the Table 8. In category C1 all dimensions are in red showing low focus, and in category C4 all in green showing high focus, except 'Emotional' in amber denoting a medium focus. The figure could also be drawn with concentric circles starting from the

middle rather than starting from the bottom. However, this design was chosen as it highlights the hierarchical nature of technology use from low to high.

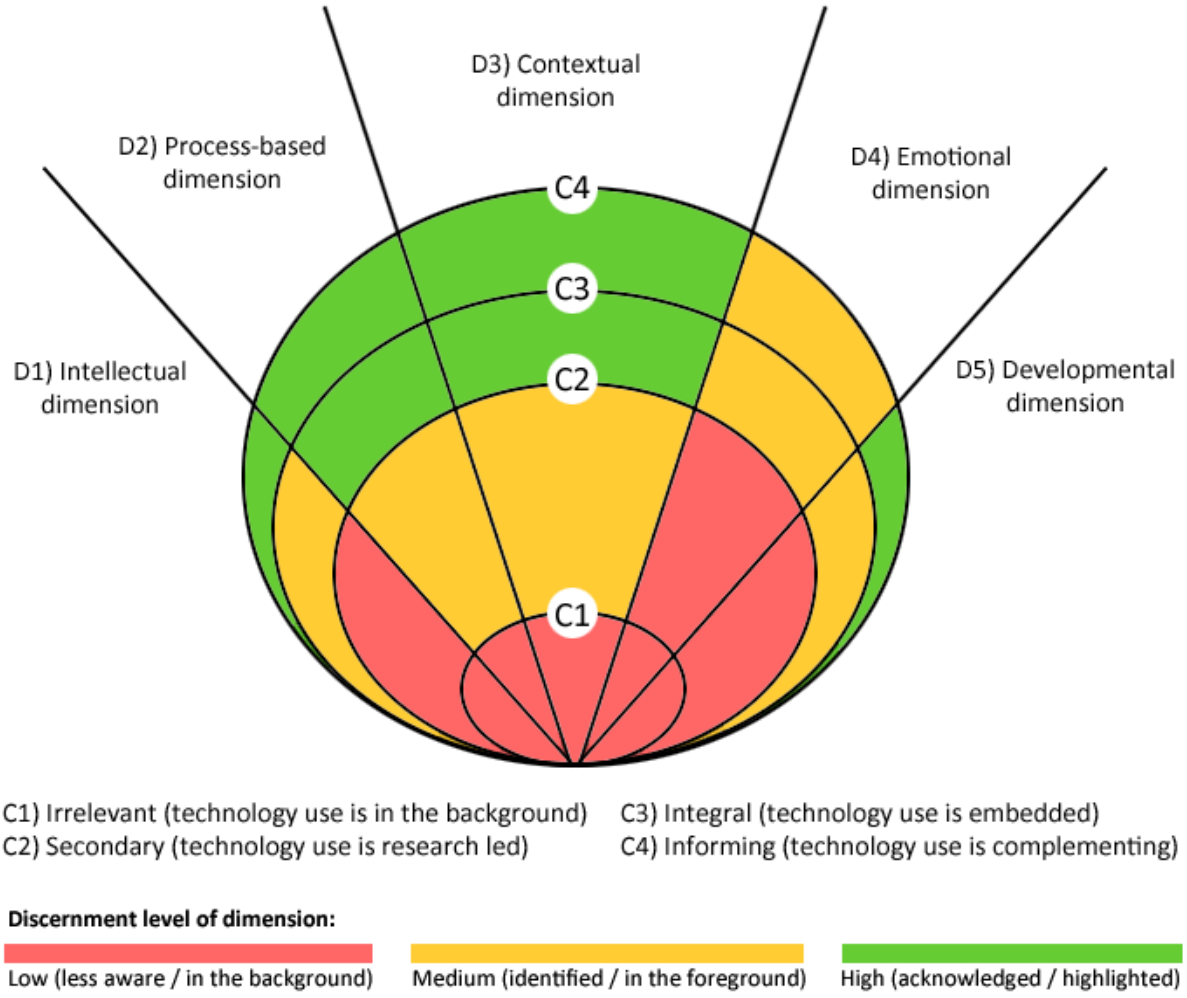

Figure 12: Outcome Space mapping the Categories and Dimensions

The slimmer areas of the higher categories (C4 and C3) represent that there were lesser evidences of my participants' experiences in such categories compared to thicker areas of the lower categories (C2 and C1). The concentric circles illustrate that higher categories of experience have higher focus on technology use, and they encapsulate other lower categories of experiences with lower focus on technology use. In other words, category Secondary (C2) contains some technology use experiences that are Irrelevant (C1); and the category Integral (C3) contains some experiences of categories C2 and C1; and the category Informing (C4) contains experiences of categories C3, C2, and C1. For example, a researcher using specialist software to inform their research approach (C4) would

experience another not so specialist software as only Integral (C3). Similarly, use of an everyday technology can be experienced as Secondary (C2) to the same researcher whilst use of some technologies such as pen and paper can be experienced as Irrelevant (C1) or in the background. However, a researcher experiencing technology use as Integral (C3) is less likely to experience it as Informing (C4) which is a higher category experience. For example, a researcher using webcams for interviewing might experience it as Integral (C3) for their research but not necessarily as Informing (C4) their research.

Chapter conclusions

This chapter answered the third research question on the ways researchers experience or conceptualise technology use in non-STEM research. Using a phenomenographic analysis the four prominent ways (as categories of descriptions) researchers experience technology use have been identified as C1) Irrelevant (technology use is in the background); C2) Secondary (technology use is research led); C3) Integral (technology use is embedded); and C4) Informing (technology use is complementing). Further analysis of these variations with researchers' experiences of researching contributed to form five critical aspects or dimensions of variations: D1) Intellectual, D2) Process-based, D3) Contextual, D4) Emotional, and D5) Developmental. Categories and dimensions were validated using participant quotations in terms of their level of focus on the critical aspects. Finally, an outcome space, illustrating the relationship of categories has been presented with brief discussion of its design. These varied experiences illustrated that the different ways in which researchers experience technology use are not random but logically related and dependant on their ability to simultaneously discern multiple critical aspects.

Drawing together the findings from Chapters 4, 5, and 6 the next chapter starts with a discussion of researcher's use of technology and presents the overall conclusions.

Chapter 7: Researchers' use of technology: Discussion and conclusions

Introduction

The previous three chapters analysed researchers' experiences of researching, their use of technology, and their experience and conceptions of using technology for research. This discussion and conclusion chapter brings the key arguments from the findings chapters together and argues that researchers' use of technology has a strong relationship with their conceptions of research and can vary according to those conceptions and their technical skills. Drawing on my theoretical framework outlined in Chapter 3, this chapter examines four categories of experience of technology use (identified in Chapter 6), and analyses their links with researchers' conceptions of research (described in Chapter 4) and the characteristics of technology use (Chapter 5). This chapter also discusses how individual researchers might move between categories of experiences, and the relevance of researcher development in supporting researchers' use of technology. Addressing the research questions, the key arguments and contribution to knowledge are then outlined. The chapter ends with conclusions and recommendations for further study.

Research-technology nexus in non-STEM disciplines

Disciplinary differences

Based on the literature, this thesis takes the stance that there are disciplinary differences between STEM and non-STEM fields in terms of research practices as well as in the use of technology for research. Studies about researchers have tended to be either across disciplines or discipline specific (Pham et al., 2005, p. 216). My study, however, includes multiple sub-disciplines although from within the broader umbrella of non-STEM disciplines. From the literature review it was noted that use of technology for research appears to be limited and explanations for the same include concerns about research becoming interdisciplinary which is less valued than monodisciplinary (Davé et al., 2016, p. 9). Such conceptions can create apprehension when using technology for non-STEM research.

Although my study did not focus on the comparison of technology use among disciplines, sections below identify some technology related issues in non-STEM disciplines.

Non-STEM research generally deals with a large amount of text-based data which is different from numeric data. Text has inner and contextual meanings that a human needs to think about and interpret. Technology available to my participant researchers could only present the patterns and groups within data depending upon affordances of the technology they chose. In addition, reading textual content on screen (direct light) is less comfortable to the eye than reading on paper (reflected light) (Jabr, 2013). Sustaining this, a number of studies favour reading print media as it is better for comprehension (Mangen, Walgermo, & Brønnick, 2013; Singer & Alexander, 2017). The intellectual element of research reading, compared to leisure reading, would also add to the cognitive load. Hence it is understandable for researchers to do some or all of their research analysis in print form, even if doing so lacks the efficiency and ease of managing their reading. The current lack of intuitiveness in user interface felt by my participants suggests that it might be an area for further development by CAQDAS vendors and developers.

Unlike teaching, my study found that most researchers often did their research in isolation and at home (see Chapters 4 and 5). This meant use of technology depended upon whether or not they had consistent access to technology at work, at home and at the location of data generation. Some researchers did not have access to the technology they wanted or when they wanted it. The additional challenge was that although some researchers had the technologies at their institution, having them available at home where they often worked was not easy. So, in non-STEM research, technology accessibility and mobility is important. In a STEM laboratory, technologies might be associated with specialist equipment and are proprietary and too expensive to have at researchers' homes and, perhaps, are also less portable. In non-STEM, however, there is a higher expectation of technologies being less complex than in STEM, and so have the potential to be accessed from various locations.

Having briefly discussed the disciplinary differences, the section below starts by addressing each of the research questions. It then moves on to discuss the meanings and applications of the findings and conclusions.

Varied experiences of researchers

- RQ1. What are non-STEM researchers' experiences of doing research?

Research and scholarship are often used interchangeably but they are not the same. Scholarship is about being intellectually interested or accomplished in a subject and could be seen as an activity more broad than the doing of 'research' which focuses instead upon more specific areas of interest and the creation of new knowledge therein (Central Queensland University, 2010). The term research here encapsulates intellectual activities such as discovery of knowledge, new understanding and interpretation; and process-based activities referring to systematic or methodical approaches to activities such as organising or structuring of data and facts (Bent et al., 2007, p. 83).

One of the key arguments raised through the literature review, and confirmed in my study, was that there are common challenges among the communities of researchers but they face these challenges individually. Researchers are an understudied population and there is a case for exploring the collective identity of researchers in order to develop strategies for building the research capacity (Ashwin et al., 2015; Rees et al., 2007). My study was situated within this gap in knowledge and explored the collective conceptions of research among researchers with an aim to understand their use of technology.

The study highlighted that researchers' experiences of doing research are different to those of their teaching and other roles. Analysis from Chapter 4 illustrated that researchers' experiences of research activities varied considerably. These experiences included the production and dissemination of research, different conceptions of research-teaching nexus, and engaging in other activities even beyond academia. My findings about these varied experiences correlated with and adds to the existing literature discussed in Chapter 2. The significant pressure on researchers, in addition to conducting research, are evident in my study as well. Research production is subordinated to research reception (Colley,

2014, p. 660) and my study highlights these differences referring to the institutional emphasis on securing funding and activities beyond academia.

In summary, researchers experience significant pressures in performing those varied and challenging roles that include being a researcher, a scholar, a teacher and an administrator. Expanding on two existing models (Åkerlind, 2008a; Brew, 2001) my study grouped researchers' experiences into four categories: research as intellectual, process-based, emotional and contextual experiences. Similar conceptions of research were discussed in existing literature (Åkerlind, 2008a, 2008b; Bazeley, 2009; Brew, 2001). However, my categorisation was useful in understanding experiences of doing research from the context of using technology. This is illustrated by using the categories of research conceptions developed in Chapter 4 as dimensions of variations in understanding technology use in Chapter 6.

Researchers and technology use

- RQ2. What types of technologies do researchers use and how?

The cost of technology is falling (Bell, 2010, p. 526) and its indispensable role as an enabler is reflected in people's everyday tasks (Lupton, 2014; Sim & Stein, 2016). Technology enhancements in education (Clegg, 2011; Conole & Alevizou, 2010; Kirkwood & Price, 2014) are also being used as research instruments (Cox, 2007, p. 353), and inspiring advances are offering the potential for improved accuracy, efficiency, etc. (Markle et al., 2011, para. 48). The literature review refers (see Chapter 2) to technologies and their use in a range of ways including, ICT, e-Science, e-Research, Technology-enhanced research, e-Infrastructure, etc. From a discipline specific view, e-Social Science, Digital Humanities, Cybersociology, Digital Anthropology, Digital Sociology, etc. are in use. Also, there is a body of work highlighting a range of literacies that allude to the relevance of technology use in research. They range from Information Literacy, Digitality, Digital Literacy, Technological Literacy, etc. to use of technology in fields such as Digital Ethnography, and Digital Hermeneutics. Previous studies note a range of technologies used for research from low-tech options such as pencil and paper, to high-tech options such as digital video, and high performance computing (Tannen, 2008; Terras, 2009). In

addition, the introduction of the internet contributed to the development of networked computer technologies, use of smart phones for email, social networking, and use of search engines (Bosman & Kramer, 2015; Dutton & Meyer, 2010; Igoe, 2012; Minocha, 2014; E. A. Williams & Anderson, 1999). Thus the literature refers to a range of technologies being used.

My study found that technology use by non-STEM researchers entails much more than information or digital literacy; it is a comprehensive contextual experience well connected to their research experience. As discussed in Chapter 5, the tools used by my participants ranged from generic to specialist, basic to advanced, and established to new tools (see Appendix 4a: List of technologies used by participants). One of the significant points to be noted was that none of my participant researchers were using any large scale infrastructure that was referred to in some of the literature nor were they using the collaborative aspects of tools prominently. So in answering 'what types of technologies' are used, it can be argued that many non-STEM researchers still use relatively low-cost and individually manageable technologies. They still do not use or have the opportunity to use large infrastructure instruments such as high performance computing.

In terms of 'how technologies were used', some literature suggested that the key for researchers was discernment: fitness-for-purpose (Minocha & Petre, 2012, p. 24), for example. Experienced researchers seem to be more reflective about their choice of tools and confident about why they are using a tool (Minocha, 2014). They stick to the tool that works for them and use it in a regular and disciplined way. Having said that, the technologies used by researchers still focus on the mechanical phases of research and this pattern has not changed in the last four decades. It would appear that digital technologies and media are not necessarily changing 'what researchers do' as researchers, but 'how they do' their research activities and what it means to be an effective researcher (Igoe, 2012, section 4. Conclusion).

My participants' approaches were either to use established and everyday technologies that are also used for other activities, or use specific technologies that are required for the particular research context. Although technology was used as an enabler for both process

and intellectual research activities, my study found that non-STEM researchers considered technology mostly as a means to gain process efficiency and to save or create time for intellectual activities. The SAMR model (Puentedura, 2013, p. 5) was useful in mapping the literature in terms of how researchers used or expected to use technology. Using SAMR, my study found that researchers' use of technology stayed mostly at the 'Enhancement' half, that is 'Substitution' or 'Augmentation' wherein they use technology just as a direct substitute, or a substitute with functional improvement. There was very limited evidence of use from the 'Transformation' half, that is 'Modification' (significant task redesign) and 'Redefinition' (creation of new tasks, previously inconceivable) levels.

The majority of the participant researchers agreed that technology was indeed helpful and would have some effect on their research. It was also noted that, for some researchers the meaning of 'technology in general' was similar or not much different in the context of 'technology for research', whilst for others it was completely different. Researchers had varied conceptions of technology, such as: an object, an affordance, an effect on activities, an emotional feeling, and a form of professional development. These conceptions were not always experienced by researchers in a mutually exclusive way but as a combination that varied in different contexts. However, surprisingly, there was no evidence to suggest that these conceptions had any major effect on what technologies researchers used or how they were used. The important issues were about researcher development in terms of technical skills including access to relevant technologies, the technologies' constantly evolving nature, and the correct level of training and support when and where researchers needed it. These issues, eventually, even put off some researchers from further use of technology.

In summary, the study found that although researchers are aware of and appreciate the benefits of using technology, they still might not use it extensively. What informs the use of technology are embedded technology skills and specialist needs; everything else might be ignored. Among non-STEM researchers, technology use is led by research questions and it is used mainly for process-based activities. What is less evident are the instances of technology use informing research questions and using it to support intellectual activities.

Researchers' experiences and conceptions of technology use

- RQ3. In what ways do researchers experience or conceptualise technology use?

As discussed in Chapter 3, a phenomenographic approach is widely used to analyse the collective experiences of different populations and to map qualitatively similar conceptions into parsimonious groups. A large number of phenomenographic studies focus on teaching and learning related issues (Ashwin, Abbas, & McLean, 2016; Brown, Shephard, Warren, Hesson, & Fleming, 2016; Hallett, 2013; Paakkari, Tynjälä, & Kannas, 2011; Rolandsson, Skogh, & Männikkö Barbutiu, 2017; Wright & Osman, 2018); some focus on research (Åkerlind, 2008a; Bowden et al., 2005; Brew, 2001; Prosser et al., 2008); and others focus on use of technology (Alsop & Tompsett, 2006; Englund et al., 2017; Khan & Markauskaite, 2017; Reed, 2006; Virkus & Bamigbola, 2011). These studies about technology use mostly found phenomenography valuable to their research (Englund et al., 2017; Reed, 2006) - although some have identified its limitations (Alsop & Tompsett, 2006, p. 257). However, generally, phenomenography is used to map the qualitative variations of participants' experiences of the object of research (Khan & Markauskaite, 2017; Virkus & Bamigbola, 2011).

My study brought the experiences of doing research and using technology together in Chapter 6 and examined the variations. It has identified four qualitatively different categories of descriptions: C1) Irrelevant (technology use is in the background); C2) Secondary (technology use is research led); C3) Integral (technology use is embedded); and C4) Informing (technology use is complementing). These categories meet the phenomenographic criteria of being qualitatively distinct; structurally linked (hierarchically); and parsimonious, that is, only have limited number of categories as necessary that can capture the variations in experiences or conceptions (Marton & Booth, 1997, p. 125).

These varied categories could be explained based on researchers' awareness of critical aspects of their experiences. From the phenomenographic perspective, the variation depends on researchers' ability to simultaneously discern multiple critical aspects as dimensions of variations. The analysis identified the dimensions of variations as: D1) Intellectual, D2) Process-based, D3) Contextual, D4) Emotional, and D5) Developmental.

The first four dimensions have close links with how researchers experience research as presented in Chapter 4 whilst the fifth dimension is drawn from Chapter 5 that highlighted the characteristics of technology use among participant researchers. This illustrates that the different ways in which researchers experience technology use are not random but are logically related, and in my study this is closely linked with how researchers experience and conceptualise research and their technical development needs.

A closer examination of categories reveals the characteristics of interplay between researchers and technology use. In Category 1, there is low focus on all of the dimensions of variation and researchers are unaware of intellectual benefits, process benefits, or contextual aspects. Hence, there is no emotional connection or need for focusing on investing in developing any technology skills. Here the lack of focus is due to inexperience of technology use. In Category 2 awareness of technology use is consciously ignored as researchers want higher control (see Table 9). In both categories 1 and 2 the position of technology is external and led by research. As the categories move higher the awareness of technology use comes into focus - although in Category 3 it is unintentional. In Category 4 researchers intentionally allow technology use to inform and influence their research for the contributions it can bring. In the higher categories the position of technology is internal and has a complementary role within research. In terms of researchers' control on technology, Category 3 is more about discernment and choosing the right tool, whereas, in Category 4, the concern of control is limited and the focus is on the learning curve in mastering the tool.

CATEGORIES →	***C1) IRRELEVANT***	***C2) SECONDARY***	***C3) INTEGRAL***	***C4) INFORMING***
Researcher's awareness of technology use	Ignored due to inexperience	Consciously ignored	Unintentionally focused	Intentionally focused
Position of technology	External	External	Internal	Internal
Role of technology	Research led	Research led	Complementing	Complementing
Researchers' control	Not applicable	Higher	Discernment	Limited + Learning curve

Table 9: The characteristics of interplay between researchers and technology use

It would appear that technology use is driven by how much the researchers want to allow the technology to enable or assist them in their research. In lower level categories researchers want to control technology and keep it external to research so that it does not lead their research. In higher level categories researchers are more open and less concerned about the effect of technology use on their research. For these researchers technology is part of research and has a complementing role while recognising the need for discernment and necessary investment in relevant and timely technical skills development. A related observation is that technology does not have agency. It is 'the researcher' who has the agency, and hence technology will always be one step below the researcher in the chain of command. To examine this further, the section below uses the theoretical framework developed in Chapter 3.

Experience as subject-object relationship and awareness structure

As discussed in the methodology chapter (Chapter 3), in line with phenomenographic approaches, this thesis considers experience of technology use as a subject-object relational meaning, which varies based on researchers' awareness structure. That is, according to the theoretical framework, how researchers experience or conceptualise technology use can be explained in two parts: 1) experience as a subject-object relationship; and 2) experience as an awareness structure.

First, combining Brentano's theory of intentionality (Morrison, 1970) and Pramling's (1983) thesis, Marton and Booth (1997, p. 85) explain that in an experience, there is a what aspect (the direct object that is experienced) and a how aspect (the way of experiencing the object). The how aspect can also be divided further into how and what aspects, that is, the act of experience and the indirect object of experience respectively. Based on this notion, in the experience of technology use, the technology that researchers use is the direct object (the what). As illustrated in Figure 13, in the how aspect, there is an act of using technology, and an indirect object which is the aim of using technology (for example, benefiting, evaluating, experimenting and learning, etc.). The act of using would depend on access to the tool, familiarity, the context, etc. and the aim will depend on the research context. A similar approach has been used in a recent study of ICT-enhanced teaching

where the act was connected to the strategy of use and the indirect object was related to the intention of use (Khan & Markauskaite, 2017, p. 696). Some past studies have used strategies and intentions as structural aspects (for example, see Diehm & Lupton, 2012, p. 220). I, however, have used them here to illustrate the subject-object relationship.

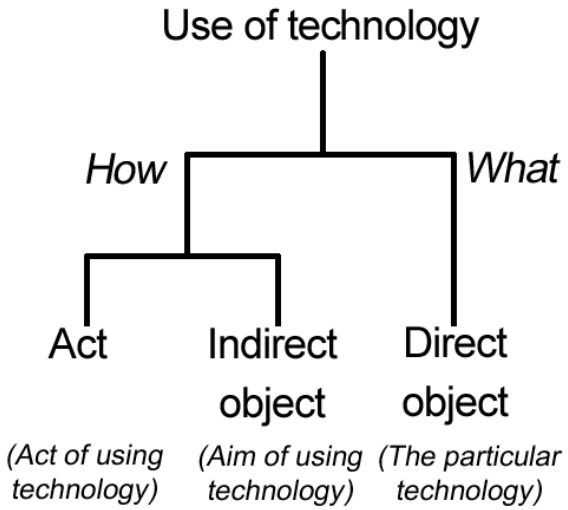

Figure 13: How and What aspect of use of technology - adaptation from Marton & Booth (1997)

Secondly, a way of experiencing something springs from a combination of aspects of the phenomenon being both discerned and presented simultaneously in the focal awareness (Marton & Booth, 1997, p. 136). In my study, different descriptions of experiences are grouped as the categories of ways of experiencing technology use in terms of the five dimensions of variation. For example, Figure 14 illustrates the structure of awareness of the category Secondary (C2). Here the dimensions D2) Process-based and D3) Contextual are in the theme (or internal horizon) and D1) Intellectual, D4) Emotional, and D5) Developmental are in the thematic field (partially in the external horizon – which includes thematic field and margin). Similarly, in other categories Integral (C3) and Informing (C4) all the five dimensions will be within the theme but the difference between those two categories would be the level of focus, that is, whether the dimensions are identified in the experience or highlighted.

Similar to Cope and Prosser (2005, p. 349), in Figure 14, I have used the original structure of awareness by Gurwitsch (1964, pp. 341–344) consisting of theme, thematic field and margin. Although phenomenographers usually combine the thematic field and the margin

into an external horizon or the context (Marton, 2000, p. 114), in my study, it is particularly important to recognise the margin and to keep it separate. Margin can be seen as a *domain of irrelevancy* (Gurwitsch, 1964, p. 344) which contains the aspects that are irrelevant to both the theme and the thematic field. As discussed earlier in this thesis, researchers have multiple roles and pressures, and when they experience the use of technology, there are a lot of aspects of irrelevancy to both the theme and the thematic field that are present in the margin. Through the categories I have identified in this study, I only claim that researchers have shown a capacity for experiencing technology use in certain ways, and I acknowledge that they are capable of experiencing it in many other ways too (Marton & Booth, 1997, p. 128). This is where recognising the margin is important. From the range of researchers' experiences present in the margin, an aspect could come into the thematic field or theme of the total field of awareness (Booth, 1997, p. 141) and present new ways and categories of experiencing.

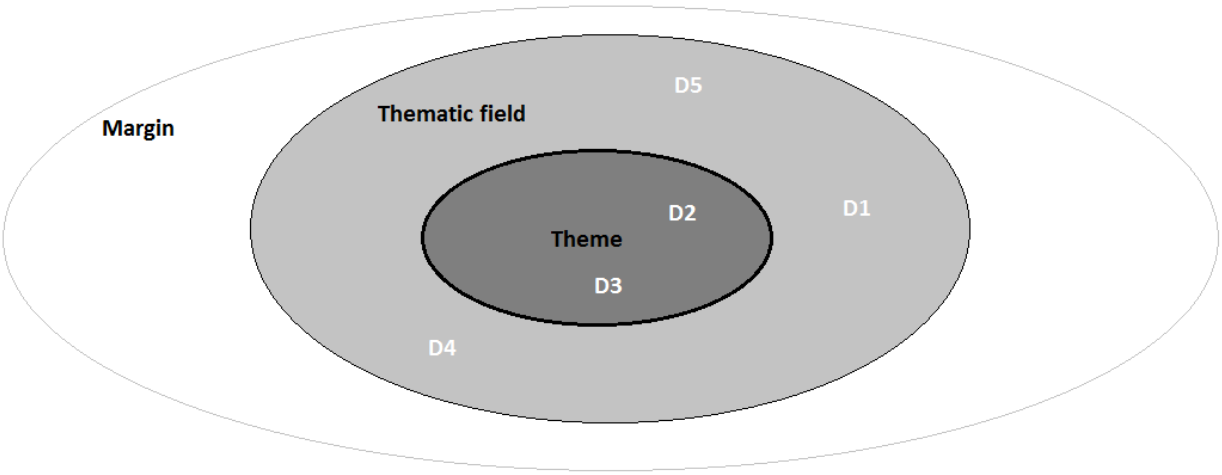

Figure 14: Field of awareness for technology use experienced as Secondary (C2)

In summary, researchers experience use of technology as a subject-object relationship that varies depending on their awareness structure in terms of how they experience and conceptualise research, and their technical development needs. I also acknowledge that the researcher could move between the categories based on how they discern different aspects depending on their own specific context or other factors. This is discussed in the next section.

Moving between categories of experience

Categories and dimensions are not comprehensive and are only a subset of all the possible ways a phenomenon can be experienced. The same phenomenographer could refine them after further analysis. For example, Åkerlind's (2008a, p. 25) model used in Chapter 4 is an updated take on her previous model (Åkerlind, 2005e, p. 152). From a constitutionalist perspective (Marton & Booth, 1997, p. 13; Trigwell & Prosser, 1997, p. 242) the idea of temporality suggests that the structure of an individual's experiences of a situation is temporal and not extended over time (Trigwell & Prosser, 1997, p. 250). That is, individuals could move from one category to another on different occasions (Marton, 1981, p. 195), informed by their previous or new experience which could bring aspects from the thematic field to the theme or vice versa (Sjöström & Dahlgren, 2002, p. 341).

CATEGORIES →	***C1) IRRELEVANT***	***C2) SECONDARY***	***C3) INTEGRAL***	***C4) INFORMING***
Direct Object	Not in focus	Not in focus	In focus	Open to expanding
Indirect Object	Not in focus	In focus	In focus	Open to expanding

Table 10: Direct and indirect object relation in moving between categories

A closer examination of the categories reveals an important relationship between how the focus is shared between direct and indirect object as mapped in Table 10. I argue that in the category Irrelevant (C1) the focus is on neither the direct nor the indirect object. That is, researchers at this point are not interested in using the technology or the benefits of using it. In category Secondary (C2), although the use of technology is still not in focus, the benefits of using it are valued and the technology is seen as a means to an end. Thus, only the indirect object (aim of using technology) is in focus. As we move to the higher category Integral (C3) both the direct and indirect object are in focus. That is, researchers are willing to learn and use the technology and are also interested in the benefits it brings. As we move to the highest category, Informing (C4), not only both direct and indirect objects are in focus but they are also open to expanding the focus to the unknown. In other words, researchers are open to using technologies (direct object) that are new to them or consider using new innovations. They are also open to new or unknown aims (indirect object) such usage can bring, for example, evaluating the suitability of a technology for a particular

research process, experimenting with new technologies and learning, etc. Thus, I argue that, from a subject-object relation perspective, the combination of foci on direct and indirect objects informs the move between categories of experiences for a researcher at a given point of time.

Powerful ways of acting spring from powerful ways of seeing

Researchers can move from one experience to another by seeing others' – for example, their peers' – experiences. This could inform their subject-object relationship, that is, the direct object (the technologies they are exposed to) and the new or different aims of using technology like benefits, evaluation, experiment and learn. It could also inform a researcher's focus on critical aspects in terms of what comes to their field of awareness. This could be an explanation of how the assertion "powerful ways of acting spring from powerful ways of seeing" (Marton et al., 2004, p. 5) happens in practice. Marton (1986, p. 33) suggests that an analysis of accounts of the different ways people experience a phenomena could "uncover conditions that facilitate the transition from one way of thinking to a qualitatively [different] perception of reality". From the variation theory it is understood that in order to discern a critical aspect an individual needs to experience its variation (Pang, 2003, p. 150). Based on my study I argue that the move between conceptions happens on two counts: 1) in terms of the changes in focus on the direct and indirect object and 2) in the change in the structure of awareness. In terms of skills development, powerful ways of acting could expose researchers to technologies and its affordances (direct object) and also bring the focus on new or different aims or benefits (indirect object) of using them. It could also contribute to experiencing the variation in an aspect and thus bring it from the thematic field to the theme or vice versa. Together, these make the powerful ways of seeing to powerful ways of acting through the change in focus on the critical aspects in their field of awareness, and the subject-object relationship in terms of the combination of focus on the direct and indirect object.

Researcher development and technology use

Supporting a conceptual change is argued to be central to professional development activities for effective use of educational technology (Englund et al., 2017, p. 84). This

could be through enabling researchers to be aware of the critical aspects and the objects of technology use (both the tool and its benefits). Chapter 5 has discussed these issues and identified development as one of the critical aspects of researchers' awareness structure of technology use.

A closer analysis showed three main characteristics that related to researchers' skills development in terms of technology use. First, the characteristics of an individual related to their attitude in terms of whether or not they preferred to distance themselves from technology and technology-related issues; whether or not they were interested in training or attending seminars; and whether or not they wished to engage in relevant discussions with peers. Second characteristic was related to their approaches to development such as autonomous learning; attend institutional training; and whether they prefer short or long training; or rather have peer support from other expert researchers who use relevant technologies. The final characteristic was resources related, in terms of access to technology; and time realistically available to improve their understanding of affordances and technical skills (learning curve).

Based on researchers' experiences and these technology use issues, a combination of autonomous and assisted learning, measuring the usage through models such as SAMR (Puentedura, 2013, p. 5), for example, would seem an appropriate way to develop researchers' use of technology. Institutions could invest in technology training for experienced researchers and expose them to the affordances and their potential. This would address challenges such as knowledge barriers and user interdependencies (Fichman, 1992, p. 199) and contribute to a more positive experience. However, availability and timing of institutional technology related training and support is a challenge and, often, researchers complain that training is not available when they need it. While there are realistic resource related challenges for institutions, this study confirms that ad-hoc rather than annual training should be available when researchers need it. Development plans for researchers need to include strategic investment and sustainability at a specialist level for scholars who have the appropriate conceptions and aptitude for technology use. Initial exposure to technology literacy, and examples of basic and innovative applications are key in demonstrating its strength and weakness as well as its opportunities and threats. This

will contribute to a balanced, well-informed development of conceptions that will provide researchers with the confidence and discernment to use technology for their research effectively and facilitate their movement between categories of experiences. However, this is not to suggest that institutions can support all custom training and technology needs of all researchers. On the contrary, specific technology support should be factored in as part of researchers' research project specifications and bids.

In summary, all participant researchers agree that technology supports or enhances research. However, the key is having discernment when making the decision to choose and use technology. Some researchers are concerned that they are missing out because they do not fully understand certain technologies and its effective uses. This area of researchers' use of technology needs further studies if governments, research institutions and research funders are to benefit from their investment.

Summary of arguments and conclusions

Key arguments

Researchers' experiences or conceptions of technology use vary depending on the critical aspects they focus on. These critical aspects in terms of dimensions of variation are related more to the conceptions of research than conceptions of technology - except the technical skills development aspect. Thus it is argued that technology use for research is more related to the conceptions of research than conceptions of technology.

Researchers could move between conceptions in terms of categories of experiences of technology use depending on the combination of focus on the direct (technologies used) and indirect object (aims or benefits of using). The movement between conceptions could also happen when the critical aspects move between the thematic field or theme of the total field of awareness. In other words, powerful ways of seeing leads to powerful ways of acting through the change in the subject-object relationship in terms of the combination of focus on the direct and indirect object, as well as the change in focus on the critical aspects in their field of awareness.

In terms of development, autonomous experiments with new or old technologies are limited among experienced non-STEM researchers. They stick to what they know from past experience in research or other contexts such as teaching and learning. What works for researchers are exposure to technologies and its affordances, and an understanding of its relevance to their research. In terms of nature of development activities, timely access to relevant technology and necessary advice and support in using them are more important rather than planned technology related CPD. Nevertheless, specialist technology that is used for a specific research and the required skills development are likely to be a researchers' own responsibility rather than the institutions'.

Conclusions

My study examined non-STEM researchers' use of technology and the findings and discussions illustrated that some disciplinary differences exist when compared to technology use in STEM areas. Researchers in general experience significant pressure from the varied and challenging roles including being a researcher, scholar, teacher and administrator. The participant researchers felt that, compared to their other roles, conducting research is a lonelier process. Many researchers found that research is more personal and less collaborative and happens at home or in private spaces unlike teaching which is more collaborative and situated at institutions.

In terms of technology use, although researchers are aware and appreciate the benefits, they still may not use it extensively. Researchers' varied simultaneous conceptions of technology do not necessarily inform their use of technology for research. What informs the use of technology is researchers' embedded technology skills and specialist needs; everything else might be ignored. It was found that many non-STEM researchers still use relatively low-cost and independently manageable technologies. Their use of technology focused mainly on the mechanical phases of research and this trend has not changed in the last four decades. Researchers still do not use or have the opportunity to use large technological infrastructure such as high performance computing.

Among non-STEM researchers, technology use is led by research questions and it is used mainly for process-based activities. Instances of technology use informing research

questions and using it to support intellectual activities are less evident. Researchers experience technology use as a subject-object relationship that varies depending on their awareness structure in terms of how they experience and conceptualise research, and their technical development needs. Among my participants, the focus on indirect object (benefits of technology use) was more prominent than the direct object (technologies used). Powerful ways of seeing prompts powerful ways of acting through researchers' change in focus on the critical aspects in their field of awareness, and the subject-object relationship in terms of the combination of focus on the direct and indirect object. In summary, all participant researchers agree that technology supports or enhances research. The key, however, is for the researchers to be more discerning when making the decision to choose and use technology. An important point is that, it is 'the researcher' who has the agency, and the technology will always be one step below the researcher.

Significance and applications of the findings and conclusions

Categories of description from this study could be considered as abstract instruments to be used in the analysis of similar cases in the future (Marton, 1981, p. 196). Also, using invariance (Runesson, 2006, p. 403), that is, keeping certain aspects fixed and varying others, researchers' use of technology could be studied further. For example, fixing all dimensions but varying Procedural (D2) and Contextual (D3) dimensions to medium might help better elevate the experience of technology from Irrelevant (C1) to Secondary (C2). Thus, understanding the variation within a set of different experiences contributes to understanding the differences in relation to each other, and to suggest how individuals may progress from one way of experiencing to another (Tan, 2009, p. 107). In the context of this study, the finding of varied experiences along with their structure and meaning will help researchers contrast and reflect upon how they experience technology in their research. For example, they will be able to think about whether they see technology use as Irrelevant or Informing or even in a completely new category of experience. Similarly, they will also be able to see what dimensions or critical aspects they focus upon when they experience technology use. Thus, researchers will be able to adapt or extend the range of categories and dimensions and move towards a more complete understanding of the phenomenon, that is, the use of technology in research.

The varied meanings and its structure identified from my study could be an efficient way to understand the complexity of researchers' experiences of technology use. It is imperative not to assume that all researchers' experiences of technology use are similar when, for example, making a policy or designing researcher development programmes. However, it is important to know how technology use is varied in a qualitative rather than just a quantitative way, so that it can be realistically and efficiently addressed. The categories and their structure from my study could be useful for researchers themselves, researcher developers and funding bodies to understand how the use of technology is experienced. For example, understanding the existence of other ways of experiencing technology use would provide researchers with some insight into how their own use of technology fits in with peers, resulting in potentially enhanced collaborative working. Researcher developers could use the findings to inform the design, planning and delivery of technology related skills development activities. For example, the outcome space developed in Chapter 6 (see Figure 12) can help gauge the range of conceptions present within the attendees or design a programme targeting a group of researchers with a particular category of experiences. Similarly, it could also help policy makers and funding bodies decide whether to target all categories of experiences or focus on particular ones. The outcome space provides a lens to better understand how researchers use technology resulting in better informed policy making and funding decisions.

The outcome space puts all categories of researchers in the focus of funding bodies rather than just investing in large e-Infrastructure and encouraging only new and innovative research approaches as experienced in the category Informing (C4). With my findings, funders could also focus on supporting other categories like Integral (C3) and Secondary (C2), and fund technology needs that are not necessarily innovative but that are stable and sustainable. Funders could invest in the development and sustainability of tools that researchers see as secondary (for example, qualitative data analysis and citation management software - which are not new ideas) so that these tools could be accessed and adopted by a wider population of researchers. This would bring open source, affordable, sustainable and stable industry standard technological tools that are not

necessarily just innovative, but more importantly, beneficial and accessible to a wider population of researchers.

Further studies on the same topic are likely to identify similar or additional categories of descriptions. Each of these categories could be used with individual context or technologies to discuss what critical aspects or dimensions are in focus while experiencing technology use in a particular way. Thus, it could begin to contribute to the much needed discussion about the relevance and effects of technology use in non-STEM research areas and related e-Infrastructure investments.

Contribution to knowledge and meeting objectives

My original contribution is the description and analysis of the qualitatively varied ways in which researchers experience technology use in their research and the critical aspects that explain these variations. Highlighting the types of technologies used and ways of using them, this thesis argues that rather than the conception of technology, it is the conceptions of research that critically informs experienced non-STEM researchers' use of technology. The study also illustrates how researcher development could contribute to moving researchers between categories of experience through the change in focus on subject-object relationship and the awareness structure.

The methodological contribution is the use of a phenomenographic approach for highlighting the issues and questions in this understudied area of researchers' use of technology. This thesis also offers insights into the range of ways in which researchers approach research tasks through the lens of technology use.

My study has met its objectives of understanding non-STEM researchers' use of technology and answered the research questions. I have also identified the limitations of this study and suggested areas for further work.

Limitations of this study

One of the limitations of this study was that the data was drawn only from a sample of 26 researchers from 10 institutions in England. This study was my learning about a certain

phenomenon in a situation of my choice and moulding, which has an effect on the research outcome both of me as the phenomenographer and of the participants (Marton & Booth, 1997, p. 129). Although the data generation was stopped due to saturation, a different set of participants from different institutions and countries could have elicited different but related critical aspects. In addition, the analysis was done by a single researcher as opposed to team analysis which could have brought interjudge reliability (Marton, 1986, p. 35; Sandbergh, 1997, p. 205).

Social media use and digital identity management are an upcoming trend (Stewart, 2012; Veletsianos, 2013; Veletsianos & Kimmons, 2012). Some of my participant researchers had a watchful eye and expected some benefits from adopting these tools and practices but their usage was at an early stage. Although my participant researchers were aware of these tools, they still had not clearly experienced its benefits. There is sound advice on researchers' social media use and digital identity management (Minocha & Petre, 2012). However, generally, digital scholarship is still in its infancy (Raffaghelli et al., 2016). This was an area of increasing importance and did relate to the use of technology; it was, however, beyond the scope of my study. Another related aspect was the issue of ethics in using online tools and data although it was not discussed as critical among the participants of my study. Nevertheless, in light of increasing technology usage in research and the upcoming renewed General Data Protection Regulations from 2018, might make ethics a critical aspect of using technology in future studies.

Another limitation of this study is its limited depth in relation to addressing the researchers' adoption of technology. Straub (2009, p. 628) identifies that most adoption and diffusion theories share 'individual', 'innovation', and 'context' as the three categories of characteristics that influence the adoption and/or diffusion of an innovation. Alluding to these three elements, Chapter 4 examined the individual – the researcher – and their experience of doing research. Chapter 5 covered the innovations and contexts together; that is the technologies used, their meanings for research, and skills development. Chapters 6 drew on both of these chapters and examined the variations of researches' technology use for research and contributed to providing some basic insights. That is, in terms of adoption of technology, in category Irrelevant (C1), the researchers were not

concerned about adopting at all. In some cases, in that category, researchers got someone else or other ways to address their needs. In Secondary (C2), the researchers only adopted stable technologies that they also used in other contexts whereas in Integral (C3), the technologies adopted were accessible and driven with minimal level of effort and a gentle learning curve. And finally, for Informing (C4), the adoption included some focused learning investments as the technology did have an active role in research. This area of technology adoption needed further analysis. However, due to the limited scope of this study factors affecting researchers' adoption and diffusion of technology (Rogers, 2003) or how and when researchers cross the chasm (Moore, 1999) in terms of when the shift in adoption happens, etc. could not be considered. However, some of the relevant issues are published as a separate journal article (Appukuttan, 2015).

Final thoughts

For scholars and researchers it should not be a case of they 'see' what goes, stays, and comes, but rather it should be they 'determine' what goes, stays and comes (Weller, 2011, p. 184). Thus, researchers should not be passive bystanders in the current surge of developing technologies, rather they should discern what could technologies do for their research and what their research could do for developing new technologies that advance their research in non-STEM disciplines. Revisiting concerns outlined in the literature review about whether researchers will be ready with progressive methods to take advantage of the emerging tools (Markle et al., 2011, para. 49) the answer would be: most likely. Although it needs further study and testing, my hypotheses is that, expert researchers with required level of technology exposure, access and professional development, are likely to use technology innovatively as they are clear about what they want it to do and will have the discernment to choose and use technology that is right for the research context.

Paradoxically, while I assert that professional development is key to researchers' effective use of technology, it does not mean that researchers have to explore and evaluate every new technology and develop themselves. I suggest it would be the role of specialist advisors and researcher developers at institutions to expose and support relevant, existing and new technologies for researchers. In fact, there is no need to impose new technologies

on researchers if the outcome could be achieved equally well with existing and stable ones. In essence, the primary focus of researchers should be to progress their research, and not to explore and evaluate new technologies, of course, unless evaluating the possibilities of technology itself is the research aim.

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Appendices

Appendix 1a: List of participants with research area and research age

Pseudonym	Research area	Bent et al. 'Seven Ages of Research' model – Age	Interview Round 1	Interview Round 2
Alice	Historical studies	6. Senior researchers	Yes	
Ben	Education and Policy	7. Experts	Yes	Yes
Celine	Education and technology	5. Established academic staff	Yes	
Don	Religious studies	5. Established academic staff	Yes	
Edwin	Historical studies	6. Senior researchers	Yes	Yes
Fiona	Education and technology	4. Early career researchers	Yes	Yes
Gary	Education and technology	5. Established academic staff	Yes	
Heather	Family and safeguarding	4. Early career researchers	Yes	
Isabel	Music and technology	5. Established academic staff	Yes	
Julia	Religious studies	5. Established academic staff	Yes	Yes
Kate	Social learning and cultural	6. Senior researchers	Yes	Yes
Luke	Music and technology	7. Experts	Yes	Yes
Megan	Literature studies	6. Senior researchers	Yes	Yes
Nelson	Historical studies	7. Experts	Yes	
Olivia	Education and Policy	5. Established academic staff	Yes	Yes
Patrick	Historical studies	5. Established academic staff	Yes	
Quin	Research practices	4. Early career researchers	Yes	Yes
Raymond	Childhood studies	7. Experts	Yes	Yes
Susan	Education and Policy	7. Experts	Yes	
Tony	Research methodologies	7. Experts	Yes	Yes
Ursula	Students in Higher Education	7. Experts	Yes	
Violet	Social changes	6. Senior researchers	Yes	
Wendy	Teacher Education	6. Senior researchers	Yes	Yes
Xavier	Business and economics	7. Experts	Yes	
Yvonne	Education and technology	5. Established academic staff	Yes	
Zoe	Classroom discourse	5. Established academic staff	Yes	Yes

Appendix 1b: Number of participants by Research Age

Research Age	Interview Round 1	Interview Round 2
4. Early career researchers	3	2
5. Established academic staff	9	3
6. Senior researchers	6	4
7. Experts	8	4
Total	**26**	**13**

Appendix 1c: Number of participants by Research Area

Research Area	Number of Researchers
Education and technology	4
Historical studies	4
Education and Policy	3
Music and technology	2
Religious studies	2
Business and economics	1
Childhood studies	1
Classroom discourse	1
Family and safeguarding	1
Literature studies	1
Research methodologies	1
Research practices	1
Social changes	1
Social learning and cultural	1
Students in Higher Education	1
Teacher Education	1
Total	**26**

Appendix 2a: Interview Schedule - Round 1

Topic: Use of technology in Social and Educational research

Introduction
Thank the interviewee for agreeing to participate. Briefly explain the aims and purpose of the study, and why they were chosen as an interviewee. Check the permission to record and discuss copyright and scope of the interview data usage. Confirm that the interviewee can choose to stop recording or withdraw completely from the interview at any stage. Confirm the anonymised use of data and adherence to ethical guidelines, for example BERA (2011).

Interview schedule
Define technology (basics: words processing, communication, managing documents/artefacts);
Duration: 5 – 10 minutes;
Note participant attributes: Gender, Age category, research experience, interview number, date, and medium (direct/telephone/internet).

Interview questions (points: current uses, relevance, acquire skills / meet needs)

1. What is it like to be a researcher?
2. What are your research interests?
3. What activities are critical to your role as a researcher?
4. Where do you need assistance in your research activities?
5. What does technology mean to you in general?
6. What does technology mean to you in research?
7. What do you expect technology to do in research? And how far it does?
8. Are you using any technology in your research? Why?
9. If yes, what are they and how do you use it?
10. On a scale of 'hindrance' to 'helpful' of technology in research, where would put yourself?
11. Are there any benefits in using technology for research?
12. Are there any drawbacks in using technology for research?
13. Are there any challenges in using technology in your research practice?
14. How do you acquire any technical skills pertinent to conducting your research?
15. Do you prefer any support in meeting the technical requirements for your research?
16. Do you seek any technical training and support?
17. Do you receive any technical training and support? Are they adequate? Why?
18. What are your strategies of choosing and using technology?
19. Are there any factors that influence your choice of technology?
20. Does your choice of technology and skills influence your research?
21. Please describe a recent instance where you used technology in your research?

Prompts: That's interesting, can you tell me more about…? Can you give me an example of ….?'

Conclusion
Check whether the interviewee would be interested should there be an opportunity to verify the transcript.

Once again thank the interviewee for their participation.

Shailesh Appukuttan

Appendix 2b: Interview Schedule - Round 2

Topic: Use of technology in Social and Educational research

Introduction
Thank the interviewee for agreeing to participate. Briefly explain the aims and purpose of the study, and why they were chosen as an interviewee. Check the permission to record and discuss copyright and scope of the interview data usage. Confirm that the interviewee can choose to stop recording or withdraw completely from the interview at any stage. Confirm the anonymised use of data and adherence to ethical guidelines, for example BERA (2011).

Interview schedule
Duration: 30 – 45 minutes;
Note participant attributes: Gender, research interests, interview number, date, and medium (direct/telephone/internet).
Interview questions (points: roles, experiences, conceptions, usage, development, policy expectations, and others' views)

A. Role as researcher

- What are you current or recent research projects and activities? Are you involved in any collaborative and/or international research?
- How do you distinguish your roles as a teacher / lectures from the researcher?
- Are activities and approaches of experienced researches different from Postgraduate researchers? Are your research approaches different from when you were a Postgraduate researcher?

B. Defining technology use in research

- What are the things that would come under the term technology in terms of your research?
- What is the relevance of technology use in your research? What role do you think technology has in your research projects and activities?

C. Communication and research

- What are your thoughts around internet and social media in your research activities?
- What do you think of using range of different communication tools such as telephone, synchronous chat, video/audio, etc. in your research practices?
- How do you disseminate your research? Does technology play any role in it?

D. Thoughts on conceptions

- "It is the pedagogy, not the technology is important"; "it is the research not the tools are important" what does these mean?
- Technology has changed the way we used to do things; does that influence your activities? (e.g. literature search, data storage, data analysis) Could technology dictate research? Does it do in your experience?
- What are the few theoretical approaches you are familiar with, and/or have used in your research activities? From those positions how do you see the phenomena of 'technology use in research'?

E. Usage of technology

- From the list of technologies (ref section 1) could you please tick the ones that you are likely to use for research, other activities, or both?
- Is the use of technology different in research from teaching and learning?
- What are the research phases (ref section 2) that you think researchers use technology? Which phases do you use technology? Why?
- Could you tell me whether you use technology in managing your research resources, literature, and references?
- Could you tell me whether you use technology in managing the data collection, analysis, storage of data?
- Do you manage your research presence or identity online? Why?

- How do you decide to use or not use a particular technology for your research activity?
- Where do you think technology cannot help?

F. Development of technical skills

- What are your views on training, development and support for researchers in terms of technology use?
- Have you received any peer support for technology use? Please describe instance if you have? How do you see peer advice and support as development model for scholars' technology use in practice?
- There could be a stigma attached to exposing/acknowledging an area of development, especially technology related; or techno-phobia? Does this apply to experienced researchers? Why?

G. Policies, frameworks, and expectations

- Are you aware of any specific policies, recommendations, and frameworks in terms of technology use in research, and expectations on researchers?
- Individual - What do you think of policies and frameworks such as below, and its effects?
  'Seven Pillars of Information Literacy - the Research Lens' – helps to prepare researchers for the technology era; focuses on various stages of dealing with information – identify, scope, plan, gather, evaluate, manage, and present.

  Vitae's Researcher Development Framework expects researchers to have advanced level of skills in interactive communication technologies, multimedia, and web tools for networking, information/data sharing and promoting research presence. While being aware of the challenges, it calls researchers to willingly learn and develop additional skills and capabilities in IT and digital technology, as appropriate.
- Institutional - HEIs and sector bodies are urged to explore the potential of new technologies to improve effective networking among researchers and support services. Why?
- The key to success for UK research include the greater focus on technologies underpinning 21st century and we should use such capability and capacity as a criterion for investing in new national infrastructure. How true or relevant is this in your experience?
- The literature notes some experienced researchers as 'lost generation who influence others in terms of what they use and deem as valued but ignores or are not aware of the implications of technological advances in research and hence not well placed to guide the next generation of researchers. What are your thoughts?
- What would it mean to have the technical skills and knowhow, for the experienced researchers who have already honed their critical and analytical skills?

H. Reflecting on issues raised by other experienced researchers

- **Access -** Knowing about and having access to tools/technology; then accessing them and developing skills; cost, location, support, etc.
- **Usage -** using what is accessible, learning curve, open to trying, peer advice, recourse, SAMR approach
- **Conceptions -** technology does the research, technology can be useful with appropriate training, technology use with discernment
- **Institutional environments -** What happens if you are to move to another institution where the culture of technology use for research and the infrastructure and facilities are different?
- From the keywords cloud (ref section 3) please could you pick a few words and reflect?

I. Closing remarks

- Is there anything you would like to add?
- So what is like to be a researcher in the 21st century?

Prompts: That's interesting, can you tell me more about…? Can you give me an example of ….?'

Conclusion

Check whether the interviewee would be interested should there be an opportunity to verify the transcript. Once again thank the interviewee for their participation.

Shailesh Appukuttan

Section 1: Technologies and contexts of usage

Technology	Research	Other
Dropbox		
Skype		
Video Conferencing		
Webinar software		
Dragon Naturally Speaking		
PcGive		
Email		
Fax		
Internet		
Websites		
British Library Catalogue		
Online Literature Catalogues		
Mobile phone		
Audio		
Images		
Turnitin		
Windows Computer		
Mac Computer		
Unix Computer		
PowerPoint		
Prezi		
Mind mapping		
Custom built software		
Atlas TI		
Nudist		
NVivo		

Technology	Research	Other
EndNote		
Google		
Google Scholar		
Facebook		
LinkedIn		
Twitter		
Microsoft Excel		
Amos 19 (SEM)		
EViews		
MLWin		
QDAS		
R		
SPSS		
STATA		
Video		
iPad or similar		
Telephone		
Pen		
Pencil		
ExpressScribe		
Transcription software		
VLE		
Wordpress		
YouTube		
Scrivener		
Word		

Section 2: Phases of research

- Setting an agenda
- Assembling collaborative team
- Defining the problem
- Reviewing the literature
- Establishing research question(s) & designs
- Conducting ethical review
- Locating available data and funding
- Developing a proposal
- Collecting data
- Analysing data
- Reporting and visualizing
- Getting peer reviewed and published
- Archiving

(E-research across Phases - Dutton & Meyer, 2010, p. 168)

Section 3: Keywords cloud

Appendix 3a: Notes on data management processes

During the interview, a password protected MS excel file was created with participants characteristics and pseudonyms were allocated. It had dates, duration, contacts, and characteristics such as gender, research-age (as referred in Chapter 3), etc. A digital audio recorder was used to record the interviews and then transferred to offline secure storage with pseudonyms as file names. The tool I used to transcribe the interviews was Express Scribe which has a simple interface and helped to pause, restart and rewind easily through keyboard shortcuts which made the process significantly easier than having to use a mouse to operate the audio controls. I used NVivo to help me manage the data and analyse it systematically. I did not need most of its functions and was often concerned that my analysis would be locked when the licence expires. Nevertheless the tool did what I wanted it to do for this research.

I see doing doctorate as a higher level training to do research. Although I was careful about not making it completely experimental, one of the initial approach was to not transcribe my second round of data. I felt comfortable managing the multimedia (audio/video) files and can analyse it directly without losing its richness and increasing trustworthiness. This is not necessarily a new approach; for example, it is noted that “working with data in its original multimedia (audio or video) state, instead of a transcription, can allow for greater trustworthiness and accuracy, as well as thicker descriptions and more informative reporting” (Markle et al., 2011). However, during the later stages of analysis when the data required multiple revisits, it was frustratingly tedious to listen to the interviewees pace as they spoke, compared to skimming the transcription. It can also be less easy to do a quick search of the data if you have not transcribed. Also, I did not find myself immersed in data during transcription process as some other researchers who shared their experiences with me. The issues were addressed by transcribing the data externally after condensing it only to the relevant parts for this study. Thus the combination of using audio and transcriptions of relevant sections seemed to improve richness and efficiency without losing rigour and quality.

All interviews were coded using NVivo excluding only the content that are unlikely to be within the scope of my area of research. All interviews were then analysed one by one by reading the transcripts and doing descriptive coding in NVivo (CAQDAS tool). At this stage most of the data looked promising and the coding began to be tedious and clunky - for example, not all questions were answered in the order I had asked and some questions were skipped as they were already covered in other areas. However, I soon realised that I needed to identify what matters more, using my conceptual framework and research questions, and understand that data collection is inescapably a selective process (Miles & Huberman, 1994, p. 55). So I started to do some generative focused writing to clarify the ideas developed through the analysis.

Miles and Huberman (1994, p. 65) states that "codes are efficient data-labeling (sic) and data-retrival devices… they empower and speed up analysis" however, "coding is hard, obsessive work… not nearly as much fun as getting more good stuff in the field". Both seemed true in my case. I was struggling to read and code detailed descriptive coding using NVivo as it was too laborious than coding using pen and paper. However, I was aware of the inefficiency issues in terms of retrieval of the latter approach. In addition I knew that these descriptive codes had to be merged to more abstract ones where applicable. Hence I decided to combine the best of both; that is, use NVivo to condense the data collected to relevant content, and group similar sections so that I can focus on key issues (e.g. skills and development were kept separate from expectations from technology). This helped to identify the similarities and variation more easily especially in examining the borderline cases (Marton, 1986, p. 43).

Appendix 3b: Table of analysis workflow summary

Key: DG – Data Generation round; RQ – Research Question

- Template analysis with DG1
  - Analysis for RQ1 and RQ2
  - Similar to grounded approach with no *a priori* themes
  - Used data from first round of interviews
  - Informed characteristics of technology use
  - Informed areas to explore further

- Phenomenographic analysis with DG1 and DG2 separately
  - Analysis for RQ3
  - Used data from first and second round of interviews separately
  - 1. Familiarization
  - 2. Compilation

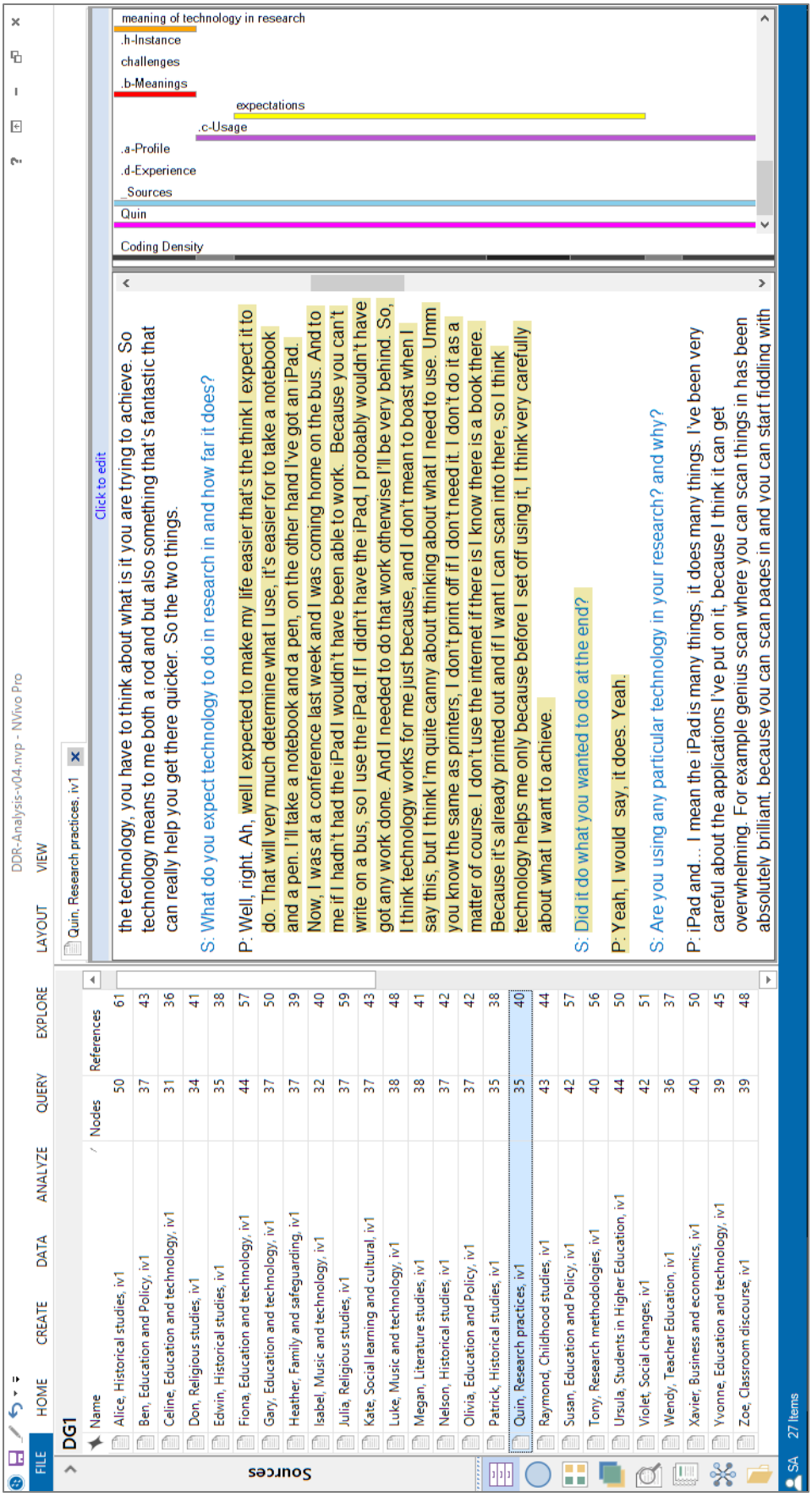
- Phenomenographic analysis with DG1 and DG2 together
  - Analysis for RQ3
  - Used all data from both round of interviews together
  - 3. Condensation
  - 4. preliminary grouping
  - 5. preliminary comparison
  - 6. naming the categories
  - 7. contrastive comparison

- Template analysis with DG1 and DG2 together
  - Analysis for RQ1 and RQ2
  - Used all data from both rounds of interviews together
  - Two models - (Brew, 2001, p. 280) and (Åkerlind, 2008a, p. 25), and *a priori* themes
  - Informed characteristics of technology use
  - Informed the PgA dimensions of variations

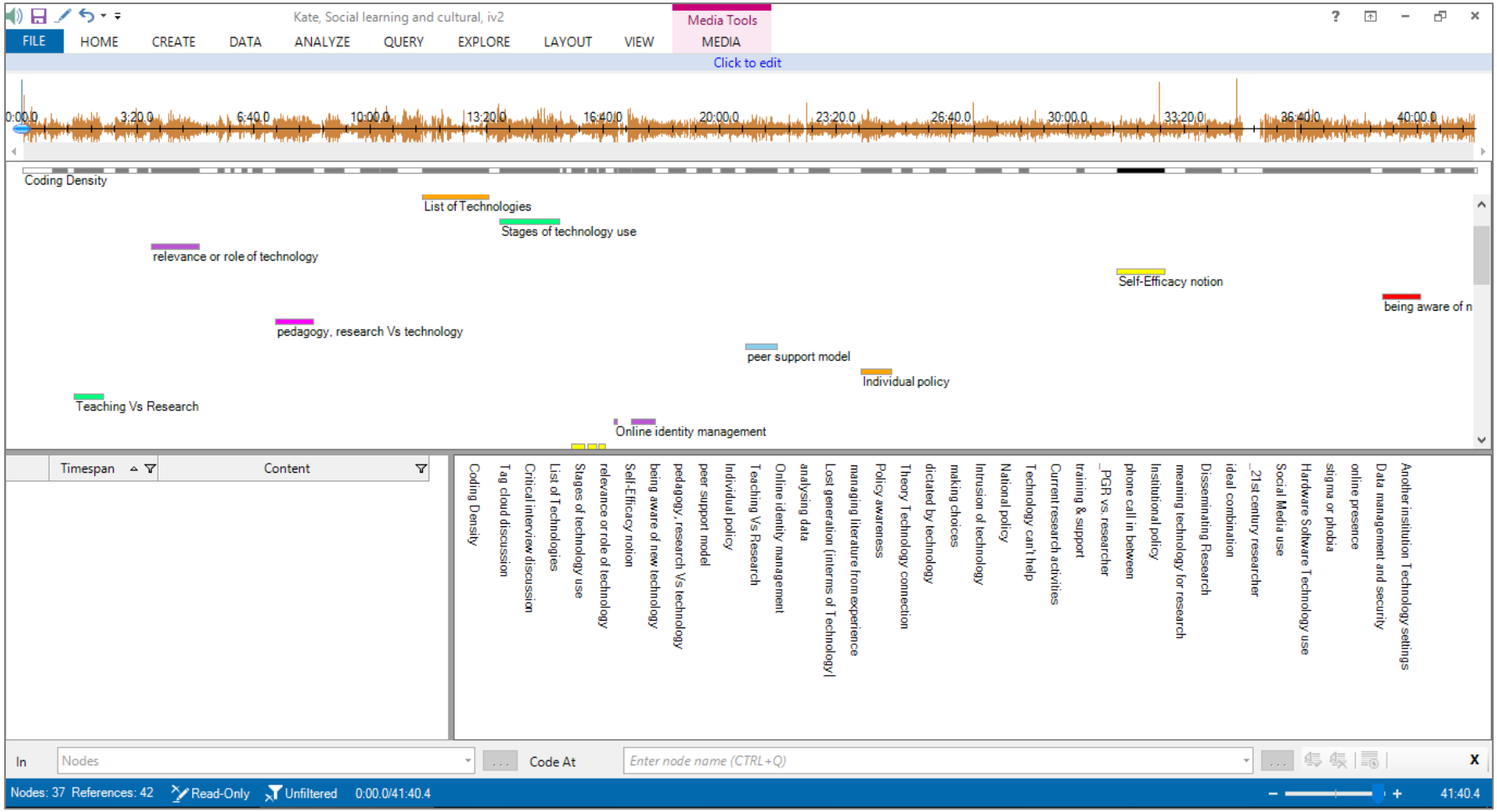
- Phenomenographic analysis (for RQ3)
  - Analysis for RQ3
  - Informed by RQ1 and RQ2 answers matching for dimensions of variation
  - Iterative rounds
  - Refined categories of descriptions and dimensions of variation
  - Developed different versions of outcome space
  - Final outcome space

Reflective note: During analysis I felt that occasionally participants are saying what I wanted to hear, or saying incorrect statements about their activities while I found clear contradicting evidence elsewhere. But for this research I had decided to take their word and not make any judgement on what they are saying. “What this boils down to … is taking the experiences of people seriously and exploring the physical, the social, and the cultural world they experience” (Marton & Booth, 1997, p. 13). So I have used data as it is said to me and interpreted from it.

Appendix 3c: Sample of transcript, codes and themes



NVivo screenshot showing list of participants, a sample transcript, codes and themes from the first round of interviews



NVivo screenshot showing analysis of a sample audio, codes and themes from the second round of interviews

Appendix 4a: List of technologies used by participants

Based on the technologies mentioned in data generation round 1

Technologies used among the participant researchers	Number of researchers used the tool for research activities	Number of researchers used the tool for other activities
PowerPoint	13	13
Telephone	13	13
Pen	13	13
Pencil	13	13
Word	13	13
Google	12	13
Email	13	12
Internet	13	12
Websites	12	11
Windows Computer	12	11
Mobile phone	11	11
iPad or similar	10	11
Skype	7	11
Microsoft Excel	10	10
VLE	3	10
Online Literature Catalogues	12	9
Images	11	9
Audio	12	8
Google Scholar	11	8
Dropbox	7	8
Video	6	8
YouTube	6	8
Turnitin	1	8
Twitter	4	7
LinkedIn	3	7
Facebook	4	6
Video Conferencing	2	6
Mac Computer	5	5
Mind mapping	3	5
Wordpress	2	5
British Library Catalogue	7	4
Prezi	4	4
Webinar software	2	4
EndNote	4	3
SPSS	3	3
NVivo	4	2

Fax	0	2
Dragon Naturally Speaking	2	1
Atlas TI	2	1
Mendeley	2	1
Onedrive	1	1
Custom built software	1	1
Unix Computer	0	1
R	0	1
Transcription software	5	0
ExpressScribe	2	0
Amos 19 (SEM)	1	0
MLWin	1	0
STATA	1	0
PcGive	0	0
Nudist	0	0
EViews	0	0
QDAS	0	0
Scrivener	0	0

Appendix 4b: Conceptions of technology

In GENERAL	In RESEARCH
As an object • a broader term than just computer that is non-manual and more than themselves (human) • applied science • Any electronic or non- electronic tool • pencil and paper, music instruments, engineering, things with batteries; • broadly all kinds of computers, hardware, software, information or digital technology	**As an object** • everything perhaps except researcher themselves can be seen as technology • interface to an issue or a tool for the job; and mostly involved computers not engineering such as mechanical things but mostly software
As Affordances + Application • affordances than hardware • sophisticated or low key; not just new tools but diffused ones too; • enabler tool - access to; making this easy; complex/ simplified, • assistive instrument for efficiency – speed and time saving • process-based tasks - networking; communication (writing, phone); organisation; • also for new opportunities	**As Affordances + Application** • Same affordances as general as well as some new affordances. • enabler with efficiency gains - making this easy; improved access to resources and people; • Applications included basic as well as advanced technology for process-based: data management and analysis, networking, communication; organisation, web media; statistics, etc.
As an effect • changed the ways of work; • affecting / shaping human action • digital impact	**As an effect** • Technology does the research or improves it; • affecting shaping both ways • other people's technology generated content • far reaching impact; • changes the research fundamentally; • increases expectation of researcher • Intellectual, organising thoughts • for robust answers • facilitating new type of research;
As Emotional • panic; technophobe • something new to learn; • could not work without it • Exciting but not that much • facilitator than 'end all'	**As Emotional** • fantastic different critical changing experience • makes tasks less boring • However, technology assisted research lack novelty and want to use material not yet digitised • Technology separate from Research
	As Professional development • Forced; having to use, must embrace; • sticks to what is used in general; or develop skills, then adopt and stabilise, eventually stick to limited sets of tools • technology access and support issues • discern and restrict technology use

Appendix 5: Audit trails – Earlier versions of Categories, Dimensions and outcome spaces

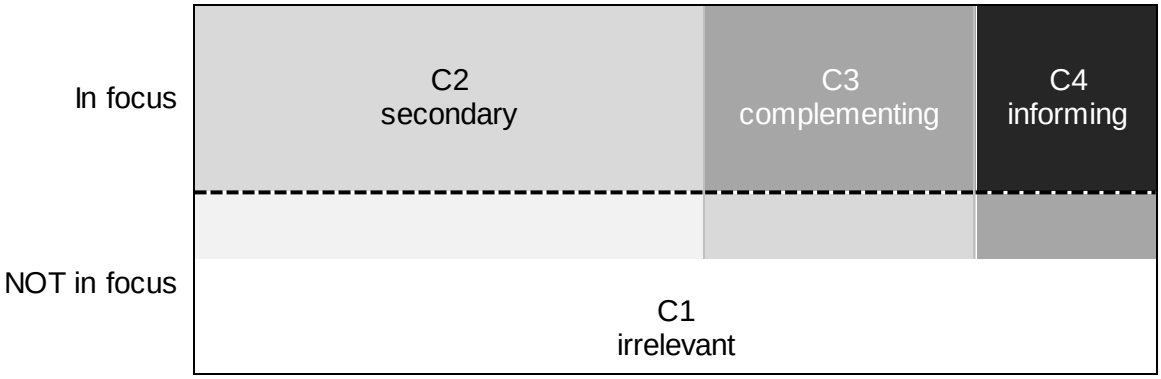
Categories and Dimensions – v1

Categories → ↓ Dimensions	A) in background with limited conscious awareness of or focus on technology use	B) external to research - as a means to an end; ***RESEARCH LED***	C) integral to research - consciously seeing research and technology as not separate *Technology use is **EMBEDDED** within Research activities*	D) developments that can inform research; Stable tech in other context	E) innovations that can define and drive new research; ***TECHNOLOGY LED***
Intellectual					
Procedural					
Developmental					
Emotional					
Contextual					
Movement	X Not applicable	Moves →	Moves →	Moves →	→ Moves to STEM

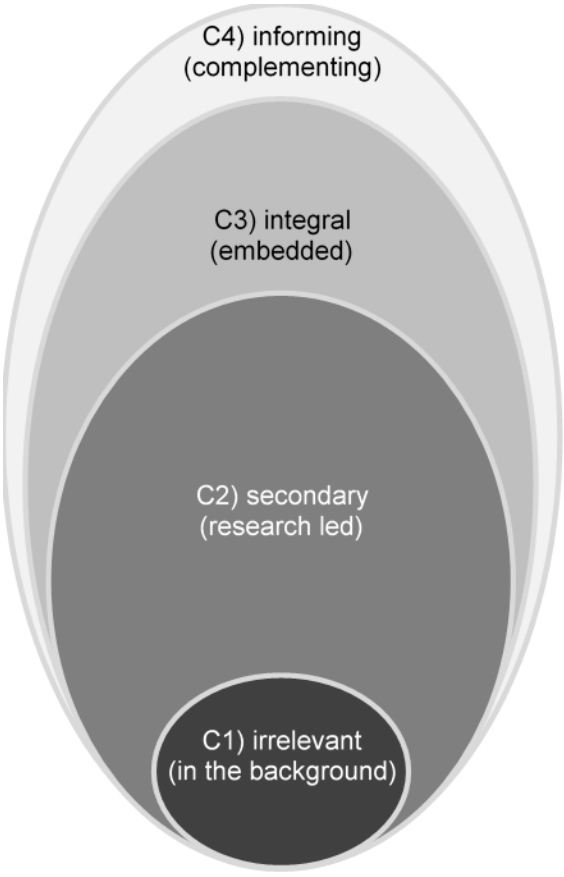
Categories and Dimensions - v2

CATEGORIES → ↓ Dimensions	***A) IRRELEVANT*** No experience or not aware or in focus	***C2) RESEARCH LED*** external to research - as a means to an end; Has control on technology. External to research	***C3) EMBEDDED*** integral to research - consciously seeing research and technology as not separate but intertwined *Technology use is embedded within Research activities*	***C4) TECHNOLOGY LED*** developments that can inform or define research; Stable tech in other context External No control Learning curve
Enabler, enhancer	Intellectual, Procedural			
SAMR	Substitute	Substitute	Substitute | Augment | Modify	Modify | Redefine
Technical skill level	Ignored, embedded, developmental,			
Emotional	From Ch4- anxiety, satisfaction, frustration, joy, interest and enthusiasm, and passionate engagement.	From Ch4- Åkerlind's range: anxiety to satisfaction, frustration and joy, interest and enthusiasm, 'passionate engagement' ,		
Technical Contextual	Need driven, volunteered, exploring, pressured, required,			
Relevance score	5	7	12	14
	Moves → C2	← Moves → C3	← Moves → C4	← Moves → STEM

Outcome space: v1: Technology use is …



Outcome space: v2: Experiencing technology use as … (to) the research



Appendix 6: Publications and conference presentations based on this study

Appukuttan, Shailesh (2016) *Researcher development and the varied experiences of being a researcher.* In: Vitae Researcher Development International Conference 2016, 12th - 13th September 2016, Manchester, UK.

Appukuttan, Shailesh (2015) *Adoption of e-Infrastructure: frontline experiences of researchers, and a model for researcher development.* Vitae Occasional Papers, 2. pp. 32-40.

Appukuttan, Shailesh (2014) *Developing experienced researchers' use of technology: examining some critical issues.* In: Vitae Researcher Development International Conference, 9th - 10th September 2014, Manchester, UK.

Appukuttan, Shailesh (2013) *Educational and Social researchers' use of technology.* In: JISC E-Learning in HE Conference 2013 - Teaching and Learning in the 21st Century, 12th February 2013, Leeds.