An investigation into the way PhD students utilise ICT to support their doctoral research process

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Preamble for the Study: *What is going on?*

Yes, I am doing my PhD; and yes, I use lots of technology in the process. But I don't see them as separate. I suppose that is normal today; technology is part of everything we do. Generally, I use it to receive and send emails, type out my work, Google information and articles, watch YouTube, connect to Facebook, and maybe listen to music sometimes. In terms of contributing to my PhD thesis, I guess the main use is for searching articles and writing my thesis. But you know computers can be annoying and irritating from time to time, so I find computer issues actually get in the way. Honestly, they slow down my doctoral research. A couple of times my supervisor had suggested I use some new software application; I said I would take a look, but really I couldn't be bothered with the hassle and frustration involved in learning how to use it. It's easier to just say, 'Yes, it looks great, I will have a look once I get some time.' My PhD is more important than learning to use a new software application. And it seems that everyone around me is doing the same thing, so I am sure I will be fine. It's not laziness, I am just being strategic☺. Completing my PhD is all that matters and not spending hours learning new software application makes me efficient.

(Assembled from various comments made by
a number of participants in this study)

Abstract

The use of Information and Communication Technology (ICT) has grown enormously in the last decade with computers and smart devices becoming indispensable in tertiary students' study practices. There is, however, limited documented research about the ways PhD students use ICT in their research practice. Under normal circumstances, it is assumed that PhD students will make use of ICT (e.g., computer technologies) throughout their research journey for a variety of generic and specialised purposes.

This study thus examines the degree to which PhD students use ICT to support their doctoral research in their daily academic practices. In order to better understand the role of ICT among PhD students in an uncontrived context, the study adopted the interpretive, naturalist enquiry and analysis approach proposed by Guba and Lincoln (1989), from social constructivist perspectives. This approach underpinned the decision to select a small number of participants from within a particular context to investigate their understandings of their experiences and use of ICT to support their research, in light of the adopted socio-technical framework (Bostrom & Heinen, 1977a). Three data sources were used in this study. Computer activity data was extracted from the computer devices of nine full time PhD students who self-reported as being skilled computer users. The second data source consisted of drawings gathered from the same group of participants about their doctoral research process involving the use of ICT. The third dataset represented photographs of this cohort of participants' work areas as well as individual and group discussion sessions about the participants' ICT use in this process.

The analysis took into account the emphasis of the socio-technical framework: the relationship and/or the tensions that exist between the PhD student participants (the social aspect) and ICT (the technical aspect). An analysis of the five areas of findings revealed that:

1) The ways PhD students used ICT in the process of undertaking doctoral research were similar, regardless of the phase of their PhD.
2) The ways PhD students used ICT in the doctoral research process were similar, regardless of their discipline backgrounds (the only difference was the frequency of the document types they accessed in their daily research practices).
3) The socio-technical systems in the doctoral research process in regard to the PhD students' goal-directed behaviours of producing a doctoral thesis in the "best possible ways" are co-adopted and co-adapted to each other at a minimum level.

4) The computer activities of the PhD students in their day-to-day research practices showed a misalignment between their level of computer literacy and their academic achievement.
5) Individual PhD students presented differences in their ways of using ICT during their doctoral research process but their concept of ICT use was not different as a cohort. In addition, the characteristics of "Curation", "Combat", "Coping" and "Conforming" situate within the context of PhD students' ICT use in the process of accomplishing their doctoral research in relation to their notion of the best possible ways to be "efficient" and "effective".

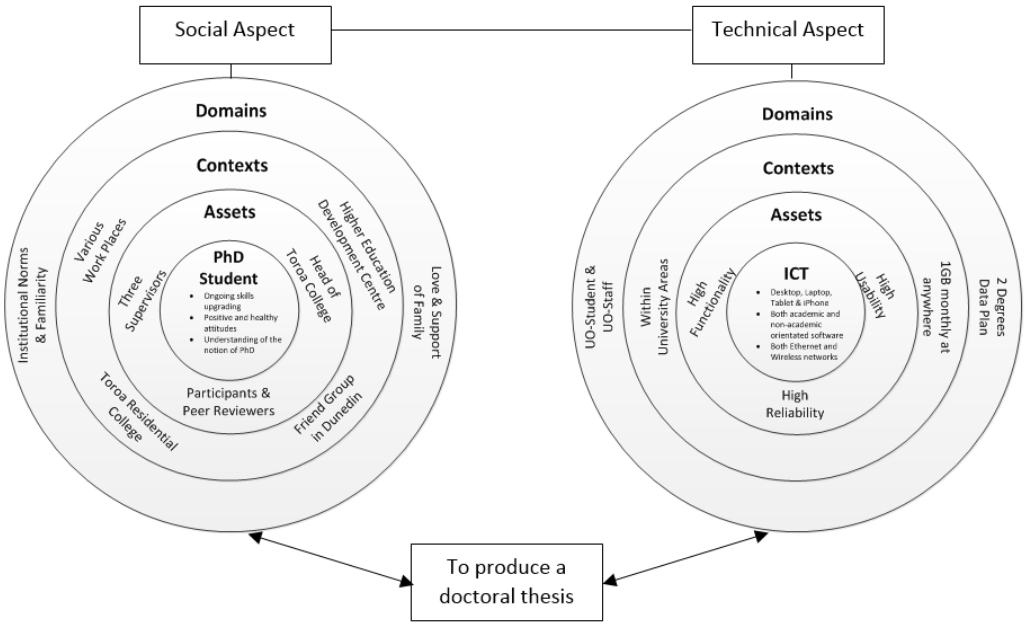
The findings of this study raise questions about the role played by ICT in advancing learning in higher education and highlights an aspect of limitation in these students' academic or research-orientated use of ICT. This could be due to taken-for-granted and/or overlooked acceptance that all students are proficient ICT users which may result in a lack of intervention, support, and emphasis of ICT support, as well as educational approach for ICT use in the process of undertaking doctoral research. The ways participants use ICT as represented in this study did not lead them to the construct of using ICT in the "best possible ways" within the doctoral research process. The tension that exists between the social (the PhD students in this context) and the technical (ICT) systems within this process could be the main concern as well as the main cause of this phenomenon. Such tension, however, could be resolved if there is a "shared" construct for the ideas of the notions of computer literacy, ICT teaching and learning, the process of carrying out PhD study, and the use of technology in this process.

In summary, the findings of this study have relevance for the broader tertiary population to engender awareness of a different way to understand research into student behaviour. In this way, the study will provide an opportunity for academics, especially supervisors of postgraduate research students, to understand to what extent ICT plays a role in PhD students' research processes and/or to what degree technological support might be required to support PhD students. Further, it is hoped that the findings generated from this study will help promote a deeper conversation about the ways PhD students use ICT in their research. Perhaps research on larger and more diverse groups of students could be considered to obtain more representative data of the student population, as this study is focussed on a small group of students at one university. Additionally, visual and situated behavioural data could be employed in researching ICT use as such data may offer new insights not found in data gathered through questionnaires and surveys.

Keywords: academic practices, actual practice, computer literacy, doctoral research, discussion, e-learning, higher education, ICT, paper-based approach, participative drawing, perception data, PhD students, photographic data, practice data, research practices, self-report of practice, socio-technical framework, teaching and learning, university

Acknowledgements

As you will learn while reading this thesis, I am very much interested in the "social" and the "technical" aspects that underpin the process of undertaking doctoral research. From my point of view, this thesis is the "output" of these two aspects, as shown in the diagram below.



Although I take full responsibility for the whole doctoral research (the centre of the social circle), I would like to acknowledge the following individuals, who contributed valuable support and assistance in the completion of this thesis:

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In an effort to avoid the inadvertent omission of any individual, I would like to acknowledge everyone around me who has directly or indirectly affected my educational experience. Their presence has inspired this study. I thank each and every one of them for their encouragement and endorsement. It would have been a tedious, stressful and lonely doctoral research process without them by my side.

Receiving all this support is a blessing. I will be forever grateful to all the aforementioned individuals.

Dedication

I would like to dedicate this Doctor of Philosophy thesis, especially

to my dearest family members for their selfless and endless love;

to the Chen family who has been a great source of motivation and inspiration;

to the Watson-Mills family in making my world brighter and more beautiful;

to my first academic supervisor, Dr Dave Ciccoricco, for making learning a joy;

to my first academic workplace, Centre for Academic Development at the Victoria University of Wellington, New Zealand for providing me a golden academic job opportunity to begin my academia life;

to all those who believe in the richness of learning and higher education;

to all those who love me dearly, your care and support for me know no bounds;

to all those I love deeply, you have meant and continue to mean so much to me.

I would like to share the practical research experience and understanding of education gained through my PhD study ~ *The gold of higher education is not to mourn the past, worry about the future or anticipate troubles, but to live in the present moment wisely and earnestly.*

May the greatest challenge yield the greatest possibility for change!

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

This chapter begins with an outline of the purpose of this study followed by the significance and the relevance of the study. It then presents the rationale and the context of the study. The chapter closes with an overview of the thesis structure. This introduction sets up a general view of the study in this thesis which examines the role of information and communication technologies (ICT) in supporting PhD students during their doctoral research process, an under-researched field in the existing literature.

1.1 The Purpose of this Study

Research has indicated that ICT are a necessary part of academic practice in higher education (e.g., Aspden & Thorpe, 2009; Henderson, Selwyn, Finger, & Aston, 2015). ICT refers to information technology in the context of the integration of telecommunications, computers, software, and the data systems that support, store, and transmit unified communication technologies for users to access and manipulate information (Murray, 2011). It is typically understood that PhD students use ICT throughout their doctoral research, yet there is little attention in the existing literature being given to how they use ICT to support their research practice in general. While the focus of this study is on the contexts in which the PhD students utilise ICT to support their research processes, including preparation, fieldwork, analysis and writing, PhD students are also known as doctoral students and/or graduate students in general. It is worth noting that the term “graduate students” in the literature includes all the students who have graduated from their first bachelor degree, which includes both masters and doctoral students.

The aim of the study was to investigate the beliefs and practices related to ICT and research processes of students as they undertake their PhD study. The investigation was framed around the following questions:

1. To what extent do PhD students at different phases of their study and from different disciplines areas use ICT to support their research process?
2. How do the assumptions and expectations of ICT held by PhD students influence their ICT practice, and how do PhD students’ ICT practices inform their perspectives on ICT use?
3. What is the relationship between the ICT assumptions, expectations, actual practice of PhD students, and related claims concerning the role of ICT documented in the

research literature?

4. How is the nature of ICT use among PhD students established from this study beneficial for different communities, including the institution, disciplines, the lecturers, the supervisors, and the students?

The answers to these questions require knowledge of the way in which PhD students use, experience, and integrate ICT throughout their research process in conjunction with the assumptions and expectations of the role of ICT from various perspectives including those from research literature, institutions, disciplines, lecturers/supervisors, and students.

1.2 The Significance and the Relevance of this Study

It has been argued that the existence of ICT in students' lives has blurred the boundaries of traditional education (Middlehurst, 2003). Access to a range of digital devices, such as desktops, laptops, smart phones, and tablets enables users to capture, share, collaborate, and publish in previously unavailable ways. As mentioned previously, research has indicated that ICT are a necessary part of academic practice; hence their usage is being promoted in higher education institutions to help students excel in their studies. While this is a claim that might be difficult to refute, the importance of ICT in a PhD student's research process has generally been overlooked in the existing research literature. For example, a search of recent publications reveals that most empirical research on doctoral education has been focused on the notion of "doctorateness" (e.g., Wellington, 2012), the candidature discourses (e.g., Strengers, 2014), the viva (e.g., Chen, 2014), supervision (e.g., Mcalpine, 2013), and the thesis examination (e.g., Clarke, 2013).

In terms of PhD students' ICT use (e.g., Blignaut & Els, 2010), documented studies have been focused on graduate students' computer literacy, communication (e.g., Lawlor & Donnelly, 2010), entertainment use (e.g., McCarthy, 2012), and the use of learning management systems (e.g., Sultan, 2010). Of these studies, while focusing on the doctoral research process or the ICT use in general, there seems to be limited research that addresses these two aspects at the same time. The lack of studies considering ICT use in doctoral research may suggest that institutions, that is, lecturers, supervisors, and/or students, hold certain assumptions and expectations regarding PhD students' ICT use. The nature of PhD students' ICT use may have been taken for granted by academia or overlooked in general. The role of ICT in supporting PhD students' research processes is thus unclear, especially the degree to which ICT are being embedded into practice at different phases in their research

process. Thus, a study examining PhD students' ICT use could be of benefit for different communities including institutions, disciplines, lecturers, supervisors, and students within the higher education context. This study addresses this lack of exploration in the literature by investigating a group of University of Otago, New Zealand, PhD students' use of ICT and their related assumptions and expectations in their day-to-day research practice.

The results of this study will be the catalyst for further applied research in this emerging field. While the findings are specific to the group involved and are therefore not generalisable to all students, the results do offer new understandings and insight into the use of ICT to support doctoral research. At the same time, the study also offers important insights into the benefits—in understanding actual practice—of using data-capturing techniques aimed at gathering naturally-occurring data as opposed to more traditional perception data approaches. These insights formed the basis of the rationale for this study, which will now be presented.

1.3 The Rationale for this Study

Much of the research pertaining to the roles of ICT in supporting students' academic practice in higher education institutions is based on perception data (a concept which will be described further in Chapters 2, 3, and 4) rather than data concerning their practices (practice data). The question can be asked whether there is a difference between students' perceptions and practices in relation to their ICT use. If there is a difference, how valid is perception data, especially in terms of understanding students' ICT use? Even if there is no difference, how do expectations and assumptions about the role of ICT influence PhD students' use of ICT in their research process, and how do the PhD students' practices inform their perspectives about ICT use?

ICT have become increasingly commonplace in higher education, especially in academic research practice, so it is worthwhile to determine the significance of ICT in PhD students' doctoral research. This study thus sought to examine how PhD students use ICT to support and advance their doctoral research process by looking at the ways students use their various ICT devices and applications for academic purposes through both perception and practice data.

1.4 The Context of this Study

As emphasised thus far, research has indicated that ICT are a necessary part of academic practice in higher education (Aspden & Thorpe, 2009; Dahlstrom, Grunwald, de Boor, &

Vockley, 2011; Guidry & BrckaLorenz, 2010; Smith & Caruso, 2010; Henderson et al., 2015). It is typically understood that PhD students have to use ICT throughout their research process. With ready access to new technologies, PhD students are well positioned to take advantage of ICT in order to carry out their research efficiently – in terms of means to an end – and effectively – in terms of reaching goals within a task.

This investigation sought to obtain a coherent understanding of the role of ICT in doctoral research in order to promote a deeper conversation in the literature about how ICT plays a role in PhD students' academic practices. Most studies approach the issues from a deterministic perceptive: that ICT are "in charge" and determine what people do with them, which includes their social practices (e.g., Jones, 2001). This is the belief that emphasises how ICT shape social practices, such as learning. But this study argues that ICT are a product of human development: they are not neutral and there is an interaction between ICT and humans (Bijker, Hugher, & Pinch, 2012). Similar to the Social Construction of Technology (SCOT) which emphasises that human actions shape the use of ICT (Pinch & Bijker, 1984), this study examined individual PhD student's research practice, the formation of self in a socio-technical system, the influence of society in socialising individuals, as well as ICT, and the effect of the development of the self with the presence of ICT. That means to study the role of ICT among PhD students not only demands a different method of investigation, but also results in different questions being raised.

In this study, the joint focus was firstly on how ICT support the PhD students' research process and secondly on how PhD students utilise ICT in their doctoral research in order to produce a thesis effectively and efficiently. Therefore, a socio-technical framework (a framework which will be described further in Chapters 2 and 3) was chosen as a useful way to examine this joint focus. Applying a socio-technical framework (Rophol, 1999) underpinned by a social constructivist's stance thus facilitated an examination of the theoretical (i.e., assumptions and expectations of ICT use) and the practical (i.e., actual practice of ICT use) recognitions of the role of ICT in carrying out doctoral research by the PhD student participants at the University of Otago. This approach was applied to the notion of producing the thesis in the "best possible ways" in order to be considered "effective" and "efficient". This socio-technical approach thus provided a useful framework to help understand the ways in which the PhD students who participated in this study engaged ICT to support their doctoral research. The PhD students' beliefs and behaviours about ICT during their process of producing a doctoral thesis revealed the nature of their interactions with ICT.

1.5 Thesis Overview

Chapter 1, Introduction, presents an overview of the study, illustrating its purpose, significance, rationale, and context. The study examined the role of ICT in supporting daily research practice among PhD students at the University of Otago, New Zealand. The chapter provides an initial preface to the issues raised in regard to this under-researched field based on the existing literature. It then demonstrates how this study fits into this field.

Chapter 2, Literature Review, explains the background context for this study in detail, followed by a description of the research settings for this context. The chapter then outlines the research paradigm of this topic in the existing literature before stating the four main themes that emerged from the review of the literature. The chapter closes with a review of typical research methodologies used in this research domain and a brief discussion about this review. This then leads into the introduction of the theoretical framework that underpinned the study.

Chapter 3, Research Design, outlines the ontological and epistemological assumptions of the researcher as well as the research approach that is reinforced by these beliefs and assumptions. A delineation of the theoretical and conceptual frameworks supporting the study follows. The chapter thus provides the overarching methodological ideas that underpinned this study.

Chapter 4, Methods, describes the data collection and analysis methods in detail. It illustrates the ways three datasets were created and developed, as well as how the findings were generated from these datasets. It then draws the analytic focus down into the results as a whole dataset. The chapter concludes with a summary of the methodology of this study.

Chapter 5, Findings, reports the results generated from the analysis of the data. It is followed by a detailed aggregated analysis of four characteristics that describe individual student participants. The chapter ends with a set of conclusion about the findings.

Chapter 6, Discussion, draws together the themes that emerged from the literature, the findings generated from the data, and the four characteristics used to describe each student participant as revealed from the findings. The arguments in these discussions underpinned the theoretical and the conceptual frameworks in this study, including that of the socio-technical framework.

Chapter 7, Summary, Conclusion, and Reflection, presents a recapitulation of the core elements of this study; the aims and the key findings, a summary of the discussion, a series of implications that emerged from this study as well as the future directions.

Chapter 2: Literature Review

2.1 Introduction

This chapter presents the literature background of this study followed by a description of related contextual research settings. The chapter then details the research paradigm that frames existing literature before stating the four main themes that emerged from the literature about this topic. The chapter closes with a review of typical research methodologies used in this research area and an overview of the introduction of the theoretical framework that was adopted for this study. The review in this chapter provides a set of foundational ideas and theoretical underpinnings upon which this study was developed.

2.2 Research Background

The use of ICT has grown enormously in the last 10 to 20 years with computers and smart devices becoming more and more indispensable to daily life. ICT are seen as vital for those wishing to engage in higher education (e.g., Aspden & Thorpe, 2009; Henderson et al., 2015). Therefore, universities, at least in the western world, are reconsidering their role and function (Ellis & Goodyear, 2010) to find new and relevant ways of teaching and learning in this ICT-rich 21st century. These rapid shifts in the use of educational technology raise questions that go to the heart of higher education, as indicated in questions asked by Katz (2008):

> Can we extend the footprint of our existing colleges and universities in ways that take advantage of scale economics, while maximising the degrees of operating freedom enjoyed by our students, faculty, operating units, international affiliates, and so forth? In short, is mass personalization of higher education possible? (p. 14)

Similarly, the following quotation from Laurillard (2010) captures these rapid shifts well:

> … the digital equivalents of slate (word processor), chalk (mouse and keyboard), library (websites), blackboards (interactive whiteboard), classroom (online forum), printing press (internet) and so on, have forced us to rethink the way we do teaching and learning (p. XV).

The digitally-connected world has turned the process of teaching and learning into a complex domain in terms of the boundary between the physical and the virtual environments, as well as their entanglements and associations, due to the easy access to global information.

2.3 Research Settings: Social Elements and Technological Elements

In this digital era, there are unprecedented possibilities and challenges navigating and negotiating processes of teaching as well as learning (Ellis & Goodyear, 2010; Nelson, 2002; Hederson et al., 2015). The fundamental message – that technology and society are entangled – continues to be difficult to absorb in an academy that has a vested interest in studying either technology or society. With this in mind, the term "e-learning" was coined in the late 1990s to refer to the adoption of electronic educational technology in the process of teaching and learning (Campbell, K, 2004; Charp, 1997; Molnar, 1997). The term e-learning is one of the key defining features of online learning, blended learning, flexible learning, and distance education in the existing literature. Authors have described the growth of e-learning variously as explosive, unprecedented, amazing, and disruptive (Garrison & Anderson, 2003).

There are few studies that have explored e-learning issues in a fully comprehensive way encompassing the various aspects related to e-learning (Goodfellow & Lea, 2007; Law, 1999). Rather, many accounts of e-learning have taken: (a) an institutional perspective, focusing on ICT facilities in the institutions (e.g., Wu & Chen, 2012); (b) a teaching focus, emphasising ways ICT can be integrated into teaching activities (e.g., Lawlor & Donnelly, 2010); and (c) a student focus, reflecting students' perspectives and behaviours in relation to ICT in learning (Bowman et al., 2014). All these have emphasised that "universities ought to be excellent learning organisations, understood in the dual sense of organisations for learning and organisations that learn" (Bijker et al., 2012, p. 106), especially with the proliferation of ICT use.

To attain this, there is a need to understand the relationship between ICT and society, including the university, in this context. Questions from Katz (2008) illustrate this well:

> Why has it become increasingly difficult to predict the channels that [ICT] may cut in higher education? [Are ICT] a tool that we control or will information and communications technologies profoundly influence and perhaps deeply disrupt higher education? (p. 11)

ICT, when viewed as objects, encompass multiple characteristics and functions of societies depending on the ways users employ them. However, ICT are "bounded by the limits of control exercised by artifactual and human operators" (Bijker et al., 2012, p. 48). At the same time, "because social groups define the problems of technological development, there is flexibility in the way things [ICT] are designed (and used), not one best way" (Bijker et al., 2012, p. 6). Technological artefacts and practices are constructions of individuals or collectives within a social group and, as such, reflect the nature of those groups.

The implication is that there are complex connections and relations between ICT and society: how do ICT play a role in society and how does society play a role in ICT? In the university context, how do ICT play a role in the process of learning and how does a tertiary student play a role in ICT use? These questions are explored further below through an examination of social elements in the technological world and technological elements in the social world, and then more specifically in terms of relationships between the social and technological elements in the context of higher education.

2.3.1 Social elements in relation to the technological world.

Social scientists consider that the existence of ICT presents "a whole range of problems that ... experts have tried to solve using a series of different methods available" (Callon, 2012, p. 77). This is because "depending on the technological frame that is described and the purposes for [undertaking this problem-solving], different elements may require different degrees of attention" (Bijker, 2012, p. 167). Such different degrees of attention are well illustrated by Bijker, Hugher and Pinch (2012) in their case of the high-wheel "Ordinary bicycle". As they explained, the use of this type of bicycle invites different interpretations from different social groups. While young men might see it as a "macho" machine, women or the elderly might consider it an unsafe machine. These differences of interpretation can also be identified in disparities of ICT use among students. The role of students in the ICT world relies on the ways students perceive and consume technological artefacts. Similar to the bicycle example, while a group of students might find using *Adobe Reader* (a computer software application) an ideal way to read, another group of students might think a document printed on paper is more comfortable and convenient. Both *Adobe Reader* and the printout are technological artefacts designed with the purpose of providing a reading platform, but users generate the meanings attributed to the artefacts. In this case, students play a crucial role in determining which artefact is preferred individually. A technological preference is developed when the interaction between the student and the artefact starts and continues. In addition, the

preference is related to the individual's conception of technological artefact designs for the specific tasks they would like to accomplish.

2.3.2 Technological elements in relation to the social world.

On the other hand, ICT can drive and shape a society. In relation to the notion of university education in this digital age, teaching and learning are "no longer bi-directional, but multi-polar with numerous ripples and eddies of intellectual experience" (Raschke, 2003, p. 60). Many universities have undergone, or will undergo, pedagogical shifts as a result of the presence of ICT (Katz, 2008; Kritt & Winegar, 2007; Land & Bayne, 2005). ICT have changed many processes of teaching and learning. For example, the use of slideshows (such as *Power Point*) instead of blackboard and chalk during lectures, or the move from the use of printed-out notes to learning management systems (such as *Blackboard*) is increasing. With ICT becoming more and more integral to the process of teaching and learning at tertiary institutions, both lecturers and students are adjusting, shifting, and changing their former approaches and the institutions themselves are exploring ways to balance technologies and traditions (Katz, 2003). Furthermore, regardless of a modern or a traditional technological artefact design, processes of teaching and learning will still influence and shape the interactions of those involved (Bijker, 2012); in this case, the communities within the university, and the complexities of sociological practices remain. In short, all technologies, whether highly sophisticated computer applications or more traditional commercially manufactured stationery, in essence offer similar core functions and opportunities for supporting the processes of learning and teaching in universities.

2.3.3 Connections between social and technological elements.

Based on the reasoning above, if society drives the use of technologies and technologies can shape society, then the social and the technological should not be perceived as separate elements (Hugher, 2012). As argued by Bijker, Hugher and Pinch (2012), "both science and technology are socially constructed cultures and … the boundary between them is a matter for social negotiation and represents no underlying distinction" (p. 5). So, while the society of the university creates and maintains technological elements in daily academic practice, technologies are also introduced and adapted to fit into these practices. Often, newer technologies such as learning management systems, are introduced to gain the benefits of efficiency, better use of resources, and increased productivity.

When the social and technological elements are seen as working in a parallel manner, it is highly possible that an optimum educational outcome can be achieved, such as increased productivity of work and/or increased effectiveness and efficiency in producing work, as well as using resources more economically (Butson, 2008; Errey & Liu, 2006; Walker, Stanton, Salmon, & Jenkins, 2007). This may be likened to Esposito, Sangrà and Maina's (2013) idea of the interconnectedness of elements within the ecologies of doctoral e-researchers. Using the paper and on-screen reader examples above, both traditional and historical artefacts are practicable, but in terms of productivity, effectiveness and, efficiency, differences may become evident. For example, reading an article using *Adobe Reader* and simultaneously taking notes that can be seen on a computer screen may be more effective and efficient in terms of time and productivity, (i.e., by entering a keyword or phrases on the *Search* button or icon, all the related pages will be retrieved with a click), than printing the article, highlighting the points, and then typing and printing them. Such efficiency and effectiveness, in terms of time and productivity, would allow one (e.g., a student) to achieve an optimum educational outcome (i.e., learning in the best possible ways).

In contrast, the resultant hard copy printed version of the notes can easily be lost and the task of retyping must be repeated if a second copy is to be acquired. With the same process being undertaken completely on a computer, not only are the notes in a form that can be printed out immediately, if the notes document has been saved, many copies of those same notes can be made without any effort other than sending the instruction for the printouts to be made by clicking the print command. In a way, the use of the hard copy printed version of the notes is less effective and efficient in terms of time and productivity. Thus, such ineffectiveness and efficiency affects the educational outcome, particularly in the aspects of producing work as well as using resources more economically.

Unavoidably, the introduction and integration of newer technologies, such as the *Adobe Reader* example discussed, can present challenges in that adopting new ways of thinking and doing well-practiced tasks is not a simple or straightforward matter. What a university is and should be as a result of the intersection of emerging technologies highlights a need for educational change, even transformation, in teaching and learning processes. Some changes that might come about could be quite dramatic and others more incremental. Whether technological changes are slow and gradual or whether they are sudden and revolutionary, the understanding of teaching and learning processes is the key to connect both social and

technological elements in the context of higher education (Ellis & Goodyear, 2010; Laurillard, 2002; Gallardo-Echenique, Marqués-Molías, Bullen, & Strijbos, 2015).

Despite applying, adopting, and adapting ICT in the process of teaching and learning, the existing work within the field of educational technology has failed to explain technology in education theoretically (Oliver, 2013). There is a paucity of studies that explore social elements in relation to the technological world and technological elements in relation to the social world. The lack of convincing links suggests that "research in this field generally treats theory and empirical work as separate, rather than integral parts of the same endeavour" (Bennett & Oliver, 2011, p. 180). This is particularly true of technological usage when the new social norms of interactions, that is, communication between students and students as well as between students and their lecturers, are facilitated (Dykman & Davis, 2008). The social intervention introduced by the technologies implies that "students' use of educational technologies may be driven primarily by the need for their studies to be flexible and manageable around work and family demands" (Tinkler, Uys, Dalgarno, Carlson, & Crampton, 2012, p. 932). Therefore, as stated by Oliver (2013), most of the existing educational technology studies could be considered as having relied "on common-sense understandings of what technology is and how it can be used, rather than to theorise it" (p. 33). To address this problem, a study that creates a coherent and bounded scope for both the social aspect (students) and the technological aspect (ICT) is necessary in order to understand the social and the technological dynamics within higher education settings, and thereby to demonstrate the relevance and place of technologies in higher education.

2.4 Research Paradigm

A considerable portion of the current literature in the field of educational technology focusses on specific use of computer technologies in academic contexts, rather than on broader issues related to connections between the social and technological elements as discussed in section 2.3. This literature suggests that student use of ICT will result in them being efficient in their learning (e.g., Smith, Salaway, & Caruso, 2009), for example, in activities such as searching information online. In addition, a number of studies claim that computer technology now plays a significant role in supporting undergraduate study (Aspden & Thorpe, 2009; Dahlstrom et al., 2011; Guidry & BrckaLorenz, 2010; Smith & Caruso, 2010). It seems evident that ICT should also help PhD students to complete their research, in doing background reading for the thesis, in conducting the various research activities, and in writing the thesis; in all phases of research, and, in the best possible ways (Jackson, 2005; Onilude &

Apampa, 2010). Therefore, it is reasonable to suggest that understanding the nature and extent to which PhD students integrate these ICT into their research practice is essential. To address this, doctoral research and the role of ICT among the current generation of students will now be discussed.

2.4.1 The notion of undertaking doctoral research.

PhD students progress through a number of phases in their doctoral research. Doctoral research leads to the process of developing the independent scholar, or a scholar who independently produces original research or new knowledge (Council of Graduate Schools (CGS), 2005). According to Gardner (2008), overall, there are three stages in the PhD candidature: (a) admission, including applying to prospective programmes and institutions and meeting and talking with faculty members, staff, and graduate students in those prospective programmes; (b) integration, including social integration with peers and faculty; the eventual choice of an advisor, a supervisor and a committee; and (c) candidacy, which is the time during which the student focuses primarily on the research. Focussing on the candidacy stage as described by Gardner (2008), this review assumes four phases:

1. Preparation, when a PhD student creates a research project proposal, reads relevant literature and constructs a research framework.
2. Fieldwork, when the PhD student collects data as planned according to his or her research framework.
3. Analysis, when the PhD student engages with the collected data, in alignment with the designed research framework and the existing literature.
4. Writing, when the PhD student writes the thesis or thesis as a fulfilment of the degree requirements.

These four phases will be referred to throughout this study.

2.4.2 The role of ICT and the current generation of students.

As defined in section 1.1, ICT are the integration of telecommunications, computers, software, and the data systems which enable users to access, store, transmit, and manipulate information (Murray, 2011). For the purpose of this study, ICT are categorised into hardware, software and networks, as described below:

- hardware includes various types of computers such as smart devices, desktops, laptops, and tablets;
- software includes any set of machine-readable instruction that directs a computer's

processor to perform specific operations; and

- networks includes systems of telecommunication that allow computers to exchange data, such as wireless and Ethernet connections.

Students are well "e-equipped" with increasing numbers of ICT present in their daily lives. For example, a notebook and a pen may have been the tools for study for prior generations but today's students come to class with "e-equipment" such as smart phones, laptops and mp3 players (Economist Intelligence Unit, 2008; ITS, 2012), or even tablets. The existence of the aforementioned hardware, software, and networks offer students access to an enormous amount of information and knowledge beyond the classroom setting or the teachers' control. Such access enables students to capture, share, collaborate, and publish in previously unavailable ways. It is undeniable that the internet provides easy access to vast quantities of information (Williamson, Bernath, Wright, & Sullivan, 2007) and, despite much discussion and critique, it has been claimed that students today "think and process information fundamentally differently from their predecessors" (Prensky, 2001, p. 1). Nevertheless, such difference does not indicate if the students today are competent in using ICT for their academic practices.

This is evidenced by studies, which describe how the present generation of students "multi-task" with ICT (e.g., Zhang, Sun, Chai, & Aghajan, 2015) even though the idea of multi-tasking has been critiqued in the existing literature (e.g., Sana, Weston, & Cepeda, 2012). They take notes on a laptop, send text messages on a smart phone, while they may simultaneously have social networking software such as *Facebook* (an online social networking service) operating in the background on either their laptop or smart phone (Economist Intelligence Unit, 2008; Hembrooke & Gay, 2003; Wood et al., 2011). According to Lieutenant Colonel Greg Conti, the director of West Point's Information Technology Operations Centre (Economist Intelligence Unit, 2008), "it is impossible to sit someone in front of the World Wide Web and expect them not to use it" in today's world because "today's students are used to getting what they need instantly" (p. 12). Again, such instant consumption of knowledge from the digital space does not imply whether the students are competent in using ICT for academic practices.

It is believed therefore, that in time, as new technologies are introduced and embedded into life more broadly, ICT will become even more interwoven into academic life. As a consequence, ICT will continue to have a significant impact on higher education (Economist Intelligence Unit, 2008; TLTTeam, 2011). The new challenge for higher education

institutions is how to "e-equip" students with the skills and knowledge required to utilise ICT effectively in the university as well as preparing them for the workplace (Economist Intelligence Unit, 2008; Güçlü, 2010). In order to "e-equip" students, it is perhaps to increase the students' computer literacy for their academic practices.

2.5 The Main Themes from the Literature

Publications from 2005 to the present have generated most of the empirical studies on graduate students' use of ICT that inform the foundational and theoretical underpinnings to this study, which aims to explore the role that ICT play in supporting PhD students' research. Rather than an earlier date, the year 2005 was chosen as a starting date for the literature review for the study presented in this thesis because of the rapid changes in ICT development since then. Most studies in the extant literature since 2005 have focused on students' computer literacy (e.g., Blignaut & Els, 2010), communication (e.g., Lawlor & Donnelly, 2010), entertainment use (e.g., McCarthy, 2012), use of learning management systems (e.g., Sultan, 2010), library use (e.g., Sutton & Jacoby, 2008) and knowledge consumption (e.g., Griffiths & Brophy, 2005). These studies have highlighted a range of aspects including skills in ICT use, the variety of ways different ICT have been used for academic practices, and students' self-confidence in the use of ICT.

Where the aspect of PhD students' use of ICT to support their research processes is concerned, the place of ICT with a focus on ways students use ICT in their research practices and research activities is often discussed in a limited way in the literature. For example, graduate students are described as "binge" users of e-journals and as having a preference for electronic resources during their thesis writing process (Dange, 2010; George et al., 2006; Liew, Foo, & Chennupati, 2000; Rowlands, Nicholas, Jamali, & Huntington, 2007; Tenopir, 2003). It is also acknowledged that all PhD students will use ICT for their doctoral research. Depending on the academic discipline, some will use software applications such as *SPSS* and *NVivo* for data analysis, while some will use software designed specifically for work in their field of study. Most, if not all, will use widespread applications that facilitate searching references, typing and archiving documents. What is important is that the nature of PhD students' use of ICT for the integrated tasks involved in their study is unclear in the current literature. This highlights that past studies do not offer a clear picture of *how* PhD students integrate computer technologies into their daily research practices but only report *what* students use computer technologies for.

In summary, a number of themes are under-represented or even missing. The positive place of ICT in graduate education has been extolled in the literature, with the focus being on information-searching through web browsers. The review undertaken here has identified four shortcomings; these will be discussed in turn.

2.5.1 Computer literacy among PhD students.

According to Pearson and Young (2002), computer literacy is about the capacity to understand the broader technological world and to use technological knowledge or capability to interact with technology. However, being competent computer users could be more extensive than much research to date assumes (e.g., Gallardo-Echenique,et al., 2015), even though there are findings in some studies which regard today's students as being part of the "digital generation" or "digital migrants" (Dobbins, 2005; Kennedy et al., 2009; Prensky, 2001). There is a common belief that students entering graduate study, especially PhD study, have appropriate computing skills for study purposes and therefore there is no need for them to engage in computer training programmes (Dange, 2010), except perhaps where specialised discipline or task-related software or hardware is concerned. Therefore, PhD students' ability to integrate ICT into their research practice is taken for granted, as a consequence of perceived or assumed readiness resulting from their undergraduate and/or Master's study experiences. However, there are a few studies showing that many graduates cannot cope with the demands of higher education, especially in terms of ICT use (e.g., Nair & Pillay, 2004; Henderson et al., 2015). In addition, there are also results from other studies suggesting that university students are not competent at using operational software such as learning management systems or office-type applications including *Microsoft Excel*, *PowerPoint*, and *Access* (e.g., Dange, 2010). Another report stated that students had high levels of ownership of application types but these applications were not frequently used (Shaw, 2000).

Further, the taken-for-granted perspectives of PhD students' ability to integrate ICT into their research practices align with research indicating that poor preparation for the demands of higher education includes students' meagre computer and information literacy skills, "techno-phobia", and low computer literacy or competency (Castles, 2004). Shaw's (2000) report also highlights that graduate students "are benefiting from the pedagogical advantages of information technology and preparing for the professional world of work", and "appropriately anticipating that skills in the use and management of information technology will be essential for advancement along their chosen career paths" (2000, p. 34). These skills have been identified as including: some basic ICT skills, such as file management, word processing,

spreadsheet manipulation, and graphical presentation (Blignaut & Els, 2010); familiarity with basic components, terms, and conditions, such as basic choice and use of hardware and software; overcoming techno-phobia; use of computer peripherals; basic formatting and editing functions; data entry; error management; use of operating systems; backing up; and basic network interaction (Blignaut & Els, 2010; Meerah, 2010; Wallace & Clariana, 2005). The questions are then: are PhD students aware of these required ICT skills and are they prepared to use these skills in the process of undertaking their doctoral research?

In short, there are limited up-to-date comprehensive studies of the level of computer literacy of graduate students, particularly PhD students and their research practices. It appears that the degree to which graduate students could be regarded as competent computer users, in terms of using basic academic software in order to complete their thesis, is still unclear. ICT are expected to be at the heart of all aspects of a student's life, especially at graduate level. PhD students are viewed as emerging researchers, and therefore knowledge of the computer literacy of PhD students and its association with ICT integration into research processes is essential, if the best support and opportunities are to be provided to ensure their success as scholars.

2.5.2 The role of ICT in the research process.

Shaw's (2000) study involving over 300 graduate students in a north-eastern US university examined students' academic computing attitudes, uses, needs, and preferences. Student perceptions were reflected in comments such as: "Using a computer makes me more organized in my graduate work"; "Using a computer makes me more motivated to do my graduate work"; "Sharpening my computer skills in graduate school is essential in my professional work"; and, the negatively worded, "I prefer to do my academic work without much use of computers" (Shaw, 2000, p.26). The students in the study claimed that the computer skills they used in their graduate and/or professional work included: "writing" (91%) and "research" (83%); a similar proportion (79%) identified "doing regular course assignments"; and roughly two thirds indicated "corresponding with professors" (68%), as well as "corresponding with classmates" (61%) (Shaw, 2000). This point outs that the purposes identified by the students focused on typical activities that are part of the research preparation phase (searching information about the topic) and the writing phase (preparing and writing regular course assignments), as well as communication tasks (corresponding with teachers and classmates).

Similarly, Ryberg and Dirckinck-Holmfeld (2010) conducted a case study emerging from the hypothesis that young people learn and solve problems as a result of their intensified use of ICT. The study highlighted that:

> We should be cautious, then, about decomposing literacies into smaller self-contained skills or 'technical' operations such as searching for information, finding pictures, creating graphics, word-processing or video editing. These operations become relevant only when they are harnessed to the students' analytical, creative and critical capabilities, and the application of these to a particular problem of real concern. (p. 181)

At the same time, Blignaut and Els' (2010) study on graduate students' computer competency for higher education showed that students' electronic file management abilities were generally good and thus they were used as a predictor for their general computer competency.

In short, the literature has mainly focused on the information searching or preparing and writing for work. The existing studies have paid limited attention to how ICT integration happens in the research process, especially at PhD student level. Students in these studies did not seem to recognise the value of ICT in the fieldwork phase of their research, for example, survey tools, recording and note taking applications, or in the analysis phase, such as the use of data analysis software. One conclusion that can be drawn is that graduates can be considered to be active computer users, especially during the writing phase, but can be considered less active users of ICT in the research process. Given the growing access to internet-based digital devices, it seems that ICT integration throughout the entire doctoral research process has not been extensively investigated. The majority of the reviewed studies discussing graduate students' ICT integration into their research practices appear to focus on certain aspects of research practice only.

2.5.3 Productivity during the research process.

Where the role of ICT in graduate students' research practices is concerned, existing studies are limited to library use (e.g., Sutton & Jacoby, 2008) or knowledge consumption (e.g., Griffiths & Brophy, 2005). This might suggest that the role of ICT in the process of conducting research is limited to web browsing or data collection. It is interesting to note that this view might also match students' view of ICT. One study (Economist Intelligence Unit, 2008) reported that about 75% of participants who were asked about ICT use in their study

said, “the greatest potential benefit of technology is something far more straightforward, namely, the expanded access to educational and reference resources that it provides” (p. 6).

According to a substantial portion of literature, graduate students prefer to use electronic resources while writing their thesis (Aderibigbe & Aramide, 2006; Dange, 2010; George et al., 2006; Liew et al., 2000; Rowlands et al., 2007; Tenopir, 2003). Studies on graduate students’ productivity, or how they make use of, or consume, information online are rare. This is particularly concerning, considering PhD students are expected to be producers of “new” knowledge. In the ECAR Student Technology Study conducted by EDUCAUSE that investigated student use and perceptions of technology, the majority reported that the benefits of technology was the easy access to resources: For students, technology today is mostly about access and efficiency (Dahlstrom et al., 2011). The study highlighted that students seem to be treating computers simply as devices for accessing web-based information, rather than devices that offer them production capabilities as well. Therefore, there may be a need to expand research foci to inquire into the ways in which graduate students use, experience and integrate ICT in their research practice, beyond web, journal, and/or information searching.

2.5.4 Graduate profile in relation to ICT integration in research practice.

It could be argued that students, especially PhD students, might not be aware of the intended graduate outcomes claimed by their institutions about their studies. This could be concerning as some of the current literature on computer integration in academia argues that graduate students now require more computing skills (e.g., in the use of computer applications) in order to advance their research practice (Case, MacKinnon, & Dyer, 2004; Wallace & Clariana, 2005). For example, adopting Wellington’s (2012) range of purposes for doctoral study, the graduate profiles for PhD students could be considered as:

- the preparation for a future role or a future career;
- the development for career or continuing professional development;
- the vehicle to develop certain generic skills that are transferable;
- personal development and achievement; and
- the product from the doctoral study.

While these graduate profiles appear to be generic, ICT integration could be embedded in them when considering the nature of a doctorate. For instance, in the preparation for a future career, ICT use is essential in any job discipline. Furthermore, the career or continuing professional development implies capability of ICT use in the process of undertaking doctoral

research. The skills of using ICT are assumed to be transferable from a doctoral study to a future career. Personal development and achievement then come into play when PhD graduates are equipped with ICT skills. Lastly, the product from the doctoral study – the thesis – requires effective and efficient ICT use in order to support the process of undertaking doctoral research in the best possible ways. However, referring to one of the studies on the job-readiness of graduates born between 1982 and 2001, one-third of the employers who responded to a questionnaire said, "some on-the-job training will be necessary to acclimatise new employees" (Economist Intelligence Unit, 2008, p. 11), especially in terms of ICT use.

The lack of awareness of the intended graduate outcomes by PhD students, particularly concerning ICT integration, indicates that they may not be as prepared for a future career as an academic or in any research-related profession. For example, there is a lack of professional development; they do not develop requisite ICT skills that are transferable; there is no personal development; and achievement and/or the product from the doctoral study, the thesis, is produced without using essential ICT skills. In short, the existing studies on how PhD students apply ICT skills in their doctoral research are insufficient to address how these skills support their research practices as well as their future career. The role ICT plays in assisting graduate research students to develop their graduate profiles is also unclear, as in how graduate students integrate ICT into their research practice to demonstrate their attainment of their graduate profiles.

Therefore, further empirical evidence about the profiles of graduate students, specifically PhD students, is needed in order to examine their engagement with ICT in their daily lives as emerging researchers and scholars. The beliefs and the findings in existing studies thus far have signalled a need for further investigation into students' ICT engagement. Such investigation is important when ICT integration in the process of doctoral research is essential, and ICT proficiency is significantly related to a student's graduate profile.

2.6 Data Gathering Methods Used in this Research Domain

Most studies on student use of ICT in higher education rely on perception data, often gathered via surveys, interviews, and questionnaires. Perception data refers to students reporting on what they believe they do, or what they have done, through post-event recollection. In an above mentioned example, graduate students self-reported as binge users of e-journals or as having a preference for using electronic resources during their graduate study (Aderibigbe & Aramide, 2006). However, the results in some studies suggested that graduate students are not

competent to the same extent in using generic spreadsheet, presentation, word processing, and database applications (e.g., Dange, 2010). As mentioned in section *2.5.1*, another report suggested that students had high levels of ownership of application types that they did not frequently use (Shaw, 2000). One of the reasons these studies raise different scenarios of graduate students' use of ICT could be that they rely on perception data, often gathered via surveys and questionnaires. Thus, none of these studies can lay a claim to knowing what students actually do in practice. This prompted Conole, de Laat, Dillon and Darby (2008) to state that, "more in-depth research is needed to understand the nuances of how students are using technologies to support their learning" (p. 512).

Furthermore, Dange (2010) suggested that more ongoing studies are required to monitor the situation as technological and educational environments continue to change. The "first necessary step of this process is an accurate and realistic assessment of the actual computer skills of the student" (Divaris, Polychronopoulou, & Mattheos, 2007, p. 144). These studies should be based on students' observable behaviours in relation to their engagement with ICT. One reason is that such findings, while relevant to explorations of graduate students' perceptions of ICT use, could also offer a convincing picture of student practice as experienced in their day-to-day practice. In Sim and Butson's (2013) study on the use of personal computers by third year undergraduate students, it was argued that "the difference between the students' beliefs about their personal computer use and their computer use highlights that self-report data reliant on post-event recollections should not be relied on to represent actual practice" (p. 338). Furthermore, there is little practical significant correlation between performance and students' expectations of additional technological support (Blignaut & Els, 2010; Sim & Butson, 2013; Wallace & Clariana, 2005). This shows that information gathered through self-rating data collection techniques could be problematic in assessing ICT use by graduate students. This assertion aligns with the findings of van Vliet et al. (1994) that self-ratings are not accurate indicators of computer skills, as students often rate their skills lower or higher than their practical skills reflect. The under-representation of certain research methodologies, such as practice data gathering methods, suggested methods should be employed to reveal students' daily technological academic practices, rather than the more traditional approaches of questionnaires, surveys, and interviews only.

Green, Rafaeli, Shrout, and Reis (2006, p. 1) also suggested that students' participation in studies might be secured by allowing them to play a "researcher-like" role in the study and gather their experiences alongside their voice and perception of technologies. While the

student voice has to be incorporated in studies to elicit and explore their e-learning strategies in different contexts, from their points of view, there needs to be a different perspective introduced, alongside and integrated with the students' self-reporting voice when examining the phenomena. Although students might be more familiar with research methods such as survey and focus groups (Dahlstrom, 2011), richer and perhaps unexpected outcomes could result from researchers engaging with research participants as peers and colleagues when collecting the data. Applying such collaborative methods recognises the participants' power and uniqueness as sources of evidence, as well as engaging them in the inquiry. It enables the introduction of first-person observational perspectives to data collection and analysis.

2.7 Summary of the Literature Review Thus Far

As highlighted in section 2.3, the existing literature has paid scant attention to the incorporation of the notions of social elements and technological elements that might be useful to frame and inform the role of ICT among PhD students at higher education institutions. Generally, what has emerged in the reviewed literature (see section 2.5) is the lack of in-depth studies on ICT use by PhD students in regard to their practices. The research into PhD students' computer literacy is also limited. Similarly, the existing empirical research has yet to consider PhD students' productivity with ICT integration in their research practice, especially in relation to graduate capabilities. Even though the literature indicates a rising interest in different perspectives on the role that ICT plays in higher education plays, such growing interests from the research community have not yet expressed the awareness of students' practices in this area. The increased inclusion of students' perspectives in this research area in recent years seems to be mainly focused on information-searching activities or measurement of computer literacy, based on self-reports. Evidence of students' actual practice alongside their self-reported perceptions is still limited (see section 2.6).

As illustrated in section 2.5, the four shortcomings that emerged from the existing literature are:

1. There are no up-to-date comprehensive studies of the level of computer literacy of graduate students, particularly among PhD students in their research practices.
2. Limited attention has been paid in the literature to how ICT integration happens in the process of research, especially at doctoral level.
3. Studies on graduate students' productivity, or how students make use of, or consume, information online, are rare.

4. There is little empirical evidence about the profiles of graduate students, specifically PhD students, in relation to their engagement with ICT as researchers.

Therefore, the literature review thus far suggests that research studies being driven by common sense assumptions about what technology can achieve (Mayes, 1995), or in which social practices are adapted to cope with challenges (Engeström, Virkkunen, Helle, Pihlaja, & Poikela, 1996) are problematic. This problem signals the need for a substantial shift in the way research studies are understood and conducted in this emerging field. Accounts of the existing educational technology studies only "explain 'education' and not 'technology'", which leads to "the failure to provide convincing accounts of the link between technology use and learning" (Oliver, 2013, p. 31). Drawing on these bases, the following sections of this literature review discuss the use of a socio-technical approach as a way to examine both students (the social aspect) and technology (the technical aspect) within the field of educational technology.

2.8 An Approach to Understanding Interaction between Humans and Technology

Many studies about human beings and technology have been concerned with technological impact on human beings, often from the perspective of technological determinism (e.g., Jones, 2001). Technological determinism is about technology shaping society and determining behaviours. From this perspective, humans are at the mercy of technologies that shape and determine their lives. Studies have also examined the perspectives of social groups on the role of technology, from a social construction of technology perspective (Pinch & Bijker, 1984). This perspective stresses human action as the shaper of technology and technology being embedded in social contexts. These two perspectives are useful in guiding investigations into the complex nature of the relationship between human beings and technology, as they provide a set of underpinning theoretical ideas that acknowledge the social and the technical. However, on their own, the two perspectives could appear to be in opposition and separate from each other.

One framework – the socio-technical framework (Bostrom & Heinen, 1977a) – that has its origins in management information systems, brings both perspectives together through the incorporation of the mechanistic or technical aspects of technology and the social aspects of technology. The framework, based on socio-technical systems, emphasises both human (social) and technological aspects within a context. The term "socio-technical" was initially introduced to recognise the interaction between humans – social factors – and technology –

technical factors – within an organisation (Trist, Higgin, Murray, & Pollock, 1963). In 1977, Bostrom and Heinen (1977a) introduced interacting variable classes within a work system to address the problems and failures of a MIS (Management Information System) from a socio-technical perspective. They believed the changes in the task and technology variables would cause more changes within other variables in the work system. Their emphasis on the changes within these variables to complement and reinforce each other is shown in *Figure 2.1*.

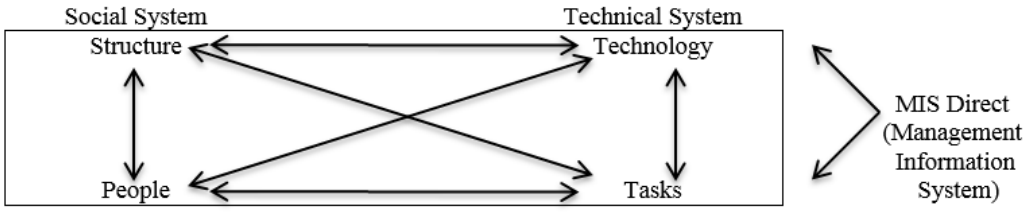


Figure 2.1. The interacting variable classes within a work system (Bostrom & Heinen, 1977a).

Figure 2.1 shows how the MIS, designed alongside social and technical systems, reallocates data processing and decision-making tasks between people and computer-related technology, as well as creates new tasks and modifies old ones to support this reallocation (Bostrom & Heinen, 1977a). Within the system, substantial changes in the work relationships among people accompany changes in tasks. Simultaneously, this applies to the relationship between the changes in structure and the changes in technology. An equally important relationship exists between the variables in social system and the variables in technical system. The changes in the people and structure (social system) are as significant as the changes in the tasks and technology (technical system). All of these types of changes are designed to complement and reinforce each other.

The association between changes in work relationships and the variables within the system fits the focus of the study presented in this thesis in a number of ways. First, the socio-technical framework emphasises the two-way relationship between human beings and technology (Errey & Liu, 2006). With a long history, the framework "intended to ensure that the technical and organisational aspects of a system are considered together" (Baxter & Sommerville, 2011, p. 2). The framework thus has relevance for the study presented in this thesis because it provides a way to focus on the two-way relationship between PhD students and their use of ICT during the process of undertaking doctoral research. Every invention, for example, any ICT device, represents a novel pattern of human action and an intervention into nature and society (Rophol, 1999). Student use of ICT, and innovations in how students might

possibly use ICT, have driven ICT development. This reflects the social construction of technology perspective mentioned above. Simultaneously, the range and functionality of ICT will have had an impact upon lifestyles in the society, including PhD students' research practices in their higher education context. This reflects a technological deterministic perspective. It is a two-way relationship which is, essentially, both a social process and a technical process. *Figure 2.2* shows how the socio-technical system framework shown in *Figure 2.1* makes sense in terms of the context of the study presented in this study.

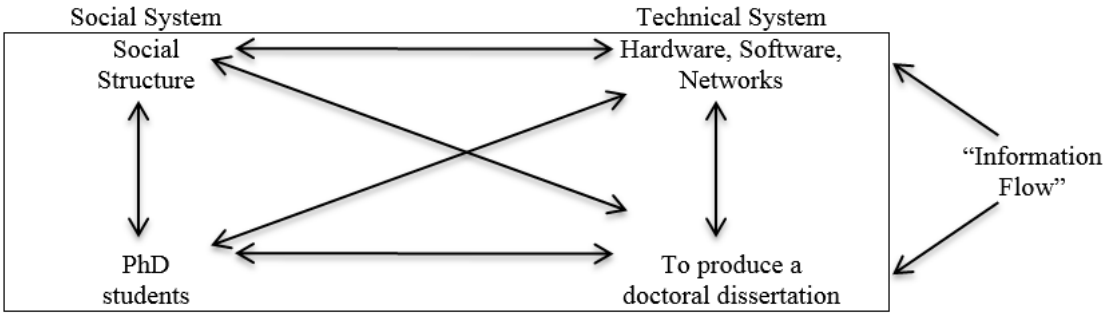


Figure 2.2. Social and technical systems in the doctoral research process.

While *Figure 2.1* presents the interacting variable classes within a work system in addressing the problems and failures of an MIS, *Figure 2.2* replaces the interacting variable classes with the context of a doctoral research process. Furthermore, instead of having an MIS designed alongside the social and technical systems (see *Figure 2.1*), "information flow" (a concept that will be explained in section 3.3) is a representation within this complex relationship between the social and technical systems in this context. The information flow reallocates information processing and the activity task (to produce a doctoral thesis) between human beings (PhD students) and technology (hardware, software and networks), as well as to create new tasks (progress in producing a doctoral thesis) and modify old ones (the completed tasks for a doctoral thesis) to support this reallocation. This flow is similar to Bostrom and Heinen's (1997a) MIS idea, as mentioned above.

In addition, the socio-technical framework shows that a shared emphasis on achievement of both excellence in technical performance and quality in people's productivity within a specific context, results in the production of a joint optimised output (Bostrom & Heinen, 1977a, 1977b; Chai & Kim, 2012). This highlights that goal of human beings and technology interrelating or working together to achieve a shared goal or a designated output (Baxter & Sommerville, 2011). Technical in this sense does not necessarily imply material technology; rather, it refers to a broader sense of technicalities (Geels, 2004), such as the procedures of

consuming and producing related knowledge. In the case of the current study, technical refers to the use of ICT in the process of carrying out doctoral research and producing an output, which is usually a research report in the form of a thesis. PhD students (the social aspect) advocate a focus on themselves and their roles, particularly in the explicit interaction they have with technology and their place in the social system (computingcases.org, n.d.). In short, it is a socio-technical system set within a particular context. The system incorporates the design of the human-technology interface and patterns of human-technology interaction (Scacchi, 2004), with the purpose of achieving the shared goal or the designated output, the thesis (the research product). The socio-technical system framework thus demonstrates the potential value of accommodating the needs of specifying and advancing the understanding of both social and technological aspects in the context of this study.

Further, notions of "path-dependence" and "lock-in" have been used to analyse stability at the level of a system that incorporates both social and technical aspects in organisation (Araujo & Harrison, 2002; Arthur, 1988; David, 1985; Geels, 2004; Jacobsson & Johnson, 2000; Unruh, 2000; Walker, 2000). Path-dependence refers to the fact that history plays a role in understanding the socio-technical development. Lock-in, however, conceptualises the outcomes of the path-dependence processes and describes how particular types of ICT play a role in a socio-technical environment within a context. For example, the notion of path-dependence is significant when two technologies compete, and the notion of lock-in suggests the winning technology stability. In a university context where the students have a choice to use either a wireless network or a plug-in network, the more dominant network sustains its position in the institution through the support of facilities. As wireless facilities become more stable, as hardware and software relying on wireless connections become more affordable and useable, as student ownership of such devices proliferate, and as student skills to make use of the wireless network develop, the more likely it is that the wireless network will become commonplace. It will be expected and assumed to exist. The emergence of such new paths based on the notions of path-dependence and lock-in has been described as a "process of mindful deviation" (Garud & Karnoe, 2001, p.1) to create new niches. The niches, in this case the use of wireless network, provide the locus for the radical innovations within a system, which includes both social and technical aspects. This means that the rules related to technical aspects are less well articulated and/or clear-cut. These rules within a multi-level framework underpinned by a socio-technical systems approach have been described more elaborately in the literature (Geels, 2002a, 2002b; Kemp & Rotmans, 2001; Rip & Kemp, 1998), which includes social and institutional rules.

An understanding of the information system or interaction network needs to therefore include an understanding of the workplace, inter-organisational networks, social worlds, and cultural milieu. Such understanding enables the situations that influence how people interact with, and through, the information systems at hand in the course of their work and the workflows being revealed (Scacchi, 2004). This realisation is illustrated in studies that have used a socio-technical approach and employed web analyses (Kling & Scacchi, 1980, 1982), contextualised design techniques (Beyer & Holtzblatt, 1997), and ethnographic methods (Viller & Sommerville, 2000) to study how people accomplish their work in an organisational setting using the information technology, people, resources, and circumstances at hand (Scacchi, 2004). Nowadays, some authorities have even broadened the definition of the socio-technical system framework to encompass a wider reach of the organisation by including the relationship of the organisation with society at large. This has become known as the environmental system (Whitworth & Sylla, 2012). In summary, a framework to view interactions and connections between humans and technology in terms of socio-technical systems is useful to inform research in the field of educational technology.

Exploring the interaction between students (humans) and ICT (technology) has been focused on in a recent study carried out by Gourlay and Oliver (2012). Oliver explored the consequences of digital media for student textual practices through the analysis of data collected by a Joint Information Systems Committee (JISC) funded project. In this investigation, Oliver examined 12 graduate students' day-to-day digital and textual practices over a six-month period, using three data collection methods: photographs, videos, and notes made on handheld devices. The findings from this study revealed "highly complex forms of engagement with literature searching, reading, note-taking, drafting and writing texts, characterized by engagement with a range of digital devices and applications, in a range of settings" (Oliver, 2012, p. 1).

This outcome points to "entanglements" between students (the social aspect) and the use of ICT (the technical aspect) in their daily academic practices, which is relevant to the research settings for the current study (see section 2.3). According to Gourlay and Oliver (2012), three types of entanglements are evident:

- Curation – a meticulous process of transformation of texts to a personalised digital depository, using techniques such as scanning and printing;
- Combat – a hesitant and uncertain attitude towards the use of ICT, having concerns such as online privacy and technical issues; and

- Coping – a number of assembled circumstances that prevent the use of ICT, encountering blockages such as the lack of capabilities with ICT and technological support.

These entanglement characteristics seem to align with the four main themes that emerged from the literature review for this study (see section 2.5), as well as the features of the socio-technical framework (see the earlier part of section 2.8), which provided an insight into the research paradigm (see section 2.4) of this study:

1. Computer literacy among PhD students – the characteristics show that students' levels of computer literacy cannot be taken for granted as all three characteristics suggest a certain degree of negative feeling towards ICT use. Students' computer literacy could be lower than generally assumed in the current literature.
2. The role of ICT in the research process – the three entanglements demonstrate the limited use of ICT in students' academic practices, particularly the characteristic of Curation which indicates students' preference for paper-based approaches. The existing literature has tended to overlook the ways students use ICT in their day-to-day study.
3. Productivity during the research process – the three characteristics did not display what or how the students could produce academic work through using ICT in their daily study practices. This is especially in relation to the characteristic of Combat, which highlights students' distrust of using ICT. It thus raises the question of whether students are using ICT to produce academic work, even though they do not believe in the benefits of using ICT.
4. The graduate profile in relation to ICT integration in research practices – the three characteristics raise a query about the "conventional understanding of 'digital literacies'" (Oliver, 2012, p. 2), specifically the characteristics of coping where the students are not using ICT in a comfortable and integrated way. This implies that there could be doubts about their graduate profile in relation to ICT use.

Overall, a review of the literature suggests what could be called a simplistic set of assumptions about the ongoing relationship between ICT and PhD students (Larsson, 2002). The matter of interest is to study, understand and describe how PhD students actually use ICT in the process of undertaking doctoral research. Drawing on the literature review, the socio-technical framework that is not commonly adopted in higher education research, together with students' characteristics in their use of ICT described by Gourlay and Oliver (2012), could

help offer an understanding of, and even new insights into, the interactions between PhD students (humans) and ICT (technology).

2.9 Conclusion

In summary, research reporting on students' ICT use has increased in recent years but the focus has been mainly limited to computer literacy measurement or information-searching activities. Growing interests from the research community have come with increased, though still limited, awareness of students' ICT practices. Importance of ICT practices for the development of the student graduate profile in relation to ICT is also still limited. The difference found between perception and practice data in the studies thus far signals the need for a substantial shift in the way to understand and gather data in this emerging field. The study reported in this thesis was undertaken to offer some new understandings and insights into these aspects. Chapter 3 will describe the methodological underpinnings of this study that were taken to address the issues raised in the literature review.

Chapter 3: Research Design

3.1 Introduction

This chapter presents an account of the ontological and epistemological underpinnings of the research design of the study reported in this thesis, as well as the research approach that was based on these underpinnings. The account is followed by a description of the theoretical and conceptual framework of the study. It then describes the broad context of the study as well as the social and technological elements as they relate to it. In this way, the chapter will set the methodological foundation and reasoning that lead to the data collection and data analysis methods presented in Chapter 4.

3.2 Beliefs Underpinning the Research

The theoretical perspective of a researcher plays an important part in defining the methodology for a social science study (Abraham, 2008). This is particularly true in studies that take an interpretative stance, as in this study (Erickson, 1986; Rowlands, 2005; Vrasidas, 2001). The way I "see" and "understand" existence is fundamental to who I am as a researcher and has greatly influenced my approach to the practice of research. For this reason, I believe it is important to give an account of my position in regard to the practice of research. I now present this position in terms of the ontological and epistemological approach underpinning the study in this thesis.

3.2.1 Ontological approach.

I do not hold to the idea that researchers can discover "objective truth". Instead, I am more comfortable with the view that "truth" is carried by the embedded values that exist within the social relations that underpin our daily lives. From this perspective, truth is relative, or context specific and relational, or negotiated and agreed upon. As a result, truth is socially constructed. All knowledge is contingent upon interactions between people and their world, and knowledge assumes that what people take as real or objective truth is based upon their interpretations according to their perspectives and experiences (Jackson & Sørensen, 2010). Rather than having a predisposed nature, we construct our social world. Any action people undertake is shaped by different types of knowledge, not only scientific knowledge, but also cultural and experiential knowledge including "common sense" and the knowledge people use in their everyday activities (Berger & Luckmann, 1967; Fuller & Loogma, 2009).

My ontological persuasion ultimately affects the way I practise academic research (Carlsson, Henningsson, Hrastinski, & Keller, 2010). Therefore, this study is context-specific, emphasising "the centrality of 'relevant social groups' and 'interpretive flexibility' in technological artifacts and change" (Pannabecker, 1991, p. 5). In the case of the current study, the relevant social group is PhD students, and interpretive flexibility includes the PhD student's knowledge about ICT objectified through generalised behaviour patterns (e.g., choice of a software application) within their community, such as the academic department within the university. What PhD students take as objective truth concerning the role of ICT in their doctoral research process is shaped by their social circles. Generalised behaviour patterns, or the accepted and embedded ways of using ICT, evolve and exist through a social mediation process where the behaviour is "agreed upon" and "mediated" through co-constructing processes within a community – in this case, by PhD students – in a specific context: the process of doctoral research at a university.

3.2.2 Epistemological approach.

In conjunction with my ontological approach, my epistemological position determines that knowledge is constructed by everyone due to the process of producing meaning or meaning-making. Constructed and co-constructed knowledge has different meanings and interpretations for various individuals or groups. As mentioned in section *2.3.1*, a bicycle could mean a convenient mode of transportation for some people, whereas it might mean technical nuisances, traction problems and ugly aesthetics to others (Bijker et al., 2012). These alternative interpretations generate different problems to be resolved. The degree to which production of meanings or interpretations is embedded in its constituency in relation to the actions taken is complex. The questions are: What is the "best" interpretation for a generalised behaviour pattern? Should interpretations be prioritised? And if so, how should they be prioritised?

I believe everything is relative in this world and images of reality are shaped from a genesis of community, for example, in this case, a community of researchers and student-participants. Relativity is mediated through mutual agreement on constructions of meanings in order to establish an agreeable outcome. This aligns with Bhaskar (1993), who indicated that we actively make and remake social structures and institutions during the course of our everyday activities. Thus, knowledge, action and reality in a pragmatic sense are not separate from each other, and they can be combined in a comprehensive theory of social action. "The manner in which reality is constructed" (Berger & Luckmann, 1967, p. 30) marks an important

contribution to our understanding of knowledge and how it relates to educational transformation, for example, the active process of change to improve effectiveness and efficiency. The idea of "knowledge" about an empirically non-existent or "yet to exist" space implies a dialectic with the empirical real (Fuller & Loogma, 2009). Such an idea of relativity supports epistemological perspectives where knowledge is situated within a social constructivist perspective (Blaikie, 2000). From this perspective, to understand a phenomenon means engaging in a process of unpacking the co-constructed meanings that exist within the various contexts. The hermeneutic dialectic process (Guba & Lincoln, 1989) is an example of how this process has been described in practical terms for researchers or evaluators.

3.2.3 Research approach based on the underpinning beliefs.

As suggested by Nelson (1994), research perspectives can be transformed if they are woven into the fabric of self-identity, having a sustained impact on both the research practice and life of the researcher. Because social constructivism underpins my views and understanding of "truth" and "reality", it was natural for me to reflect on my own practices while capturing and analysing the data. I am a PhD student myself and I have been a keen user of ICT devices, tools, and applications since finishing my primary education in Malaysia. Every discussion with, and observation of, the participants provoked my perspectives and inspired me to change my behaviours with respect to ICT use. I was encouraged to "see" through the lens of the participants, situating myself in their space, rather than placing myself apart or outside their experience. At the same time, I challenged myself to push outside my "comfort zone" to pursue further learning in order to adapt to using various academic and research-orientated software programmes in my own process of undertaking doctoral research. Nevertheless, I was concerned about the degree to which my underlying beliefs about the benefits of using ICT in the doctoral research processes would impact on my analysis. Therefore, I was vigilant in adhering to interpreting the data through a systematic research process and analysis.

Apart from building trustworthy relationships with my participants in order to obtain the "best possible" data, there was a prolonged six months of data collection period. The analysis of the data was iterative, occurring alongside ongoing data collection as I engaged in a hermeneutic dialectic process (Guba & Lincoln, 1989) with the participants. Through this process I played an interactive role, taking into account the various constructions of the meanings from the participants, with the aim of interpreting and understanding their perspectives. Through joint discussion and critique, the participants and I, as researcher, contributed to the co-construction of meanings. These constructions of meanings provided insights into individuals'

mental structures or mental constructs: patterns of thinking that are socially constructed, contextually generated and culturally influenced. Assertions were generated and were checked and rechecked with individual participants during the six month period of data collection.

3.3 The Theoretical and Conceptual Framework

As mentioned in section 2.8, a way of approaching the study of human-technology interaction is provided by the socio-technical systems framework (Trist et al., 1963). The socio-technical model applied in this study is framed within a social constructivist stance, emphasising the reciprocal relationships between people and machines a way in which technology and humanity are in harmony with each other (Rophol, 1999). The use of the model provides a way to understand the joint participation of these two-dimensional aspects in authentic situations – that is, how PhD students engage ICT in their doctoral research on daily basis – rather than seeking to separate human beings (PhD students) and technology (ICT).

Figure 2.2 presented the diagram derived from the socio-technical framework that was modified to suit the context of this study. It is presented again in *Figure 3.1* as a reminder to the readers and to facilitate understanding of its place in shaping the foundational aspects of this study.

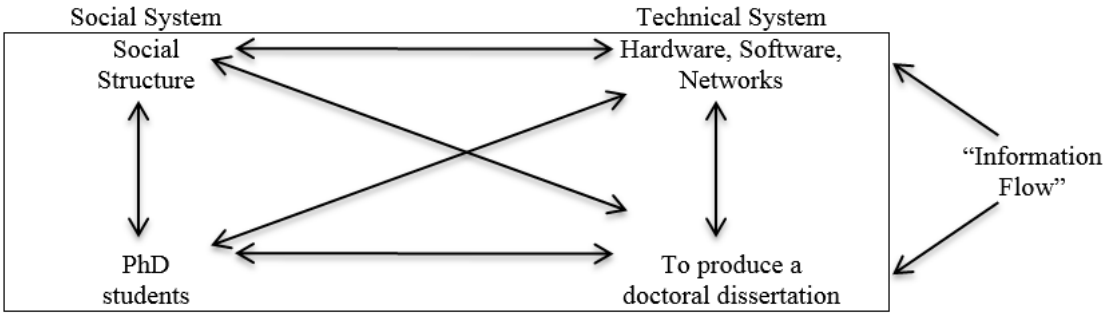


Figure 3.1. Social and technical systems in the doctoral research process.

The ongoing relationship between PhD students (social system) and ICT (technical system) based on both their perception as well as actual practice fits into the socio-technical framework, as shown in *Figure 3.1*. PhD students need to use ICT in their doctoral research to produce a doctoral thesis, and the role of ICT in doctoral research informs the students' perceptions as well as practices. ICT includes types of hardware, software, and networks needed at different phases of doctoral research (the social structure in *Figure 3.1*). For example, any ICT engagement and integration by PhD students will impact on the role of ICT

in terms of the efficiency and effectiveness in producing their thesis. To highlight this, the ongoing relationship is depicted in terms of the reallocation of the "information flow" in *Figure 3.2*.

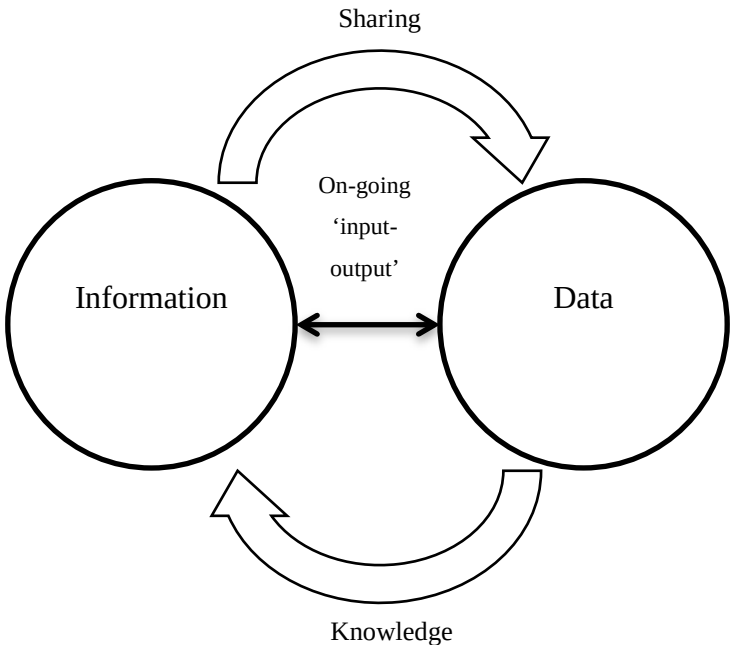


Figure 3.2. Information flow.

Figure 3.2 shows how the reallocation within the information flow is an ongoing input-output process. The nature of a PhD student's research process generally involves the development of information from data (e.g., gathered from research participants) as well as a meaning-making process of knowledge (i.e., searching digital information) into sharing (i.e., the production of a thesis) mediated by technology (ICT). Such a reallocation depends on, and is the result of, the interplay between PhD students (social) and ICT (technical). In this way, the socio-technical framework provided the structure to scaffold exploration of the relationship between "social and technical phenomena, persons and machines, the technisation of society and the socialisation of technology" (Ropohl, 1982) in the context of this study.

3.4 This Study

With the use of the socio-technical framework, this study focuses on the way in which ICT is engaged and integrated in support of a doctoral research process. It defines the priorities of having empirical data in order to present a particular view of reality. The empirical evidence then focuses on commentary and critique of a phenomenon, including what the phenomenon is and how the phenomenon happens in a particular context, rather than explanation, which is concerned more with objectivity and testable propositions. The broad context is now

described drawing on the key features of the socio-technical system that involved PhD students, their research activity, and ICT. In this way, the priorities for the empirical data collection, which will be described in Chapter 4, are laid out.

3.4.1 The broad context.

The setting of the current study was the University of Otago, a research-intensive tertiary institution in New Zealand. The specified social group in this study was a cohort of PhD students who were engaged in full time study at the University of Otago. The University is organised around four broad groupings of academic disciplines, namely, Commerce, Health Sciences, Humanities, and the Sciences, and all four offer PhD programmes. Information Technology Services (ITS) at the University provides the infrastructure and support for technology use by staff and students. An annual survey completed by ITS (2014) illustrated the general picture of ICT use among the PhD students at the University of Otago at the time this study was undertaken. The survey showed that in 2014, 98% of postgraduate students at the University owned a laptop, and the majority of them were using a desktop and/or tablet at the same time. As for the graduate attributes of a Doctor of Philosophy degree graduate, there is only one ICT related attribute that is limited to "Information Literacy". In this attribute, the graduate is described as having a "highly developed ability to apply specific skills in acquiring, organising, analysing, evaluating and presenting information, in particular recognising the increasing prominence of digital-based activity" (http://www.otago.ac.nz/otago122601.pdf). This is information literacy in a broad sense.

At present, the general ICT support for PhD students at the University of Otago is offered by the library as well as the ITS. The workshops that are run by the library consist of:

1. Library support at Otago: An interactive introduction to services and resources for postgraduate students;
2. Managing your references: Using *Endnote* to simplify the task of building a research library and citing references; plus how it works with Library resources;
3. Bibliometrics: Tools that explain impact factors and ranking for what to read, and where to publish; and
4. Surviving your thesis: An interactive workshop on thesis preparation, including copyright issues, writing, submitting and depositing.

As for the workshops run by the ITS, they are:

1. A quick intro to *SPSS*;
2. *Endnote* for Mac and PC overview;
3. *Excel* for PC;
4. Making posters;
5. *R* – Data analysis walkthrough;
6. *Word* for Mac and PC; and
7. *NVivo* overview.

The University of Otago is bounded in a wider environment or context. The interaction between the individual student and the ICT occurs not only across the boundaries within the institution but also beyond the institution (Butson, 2008). The interaction includes the interplay between people and ICT within a community, people and ICT across different communities or groups of people, and ICT within and across communities. In this sense, the concept of "the role of ICT in the doctoral research process" is actually constituted in the minds of people, especially in those of the PhD students. It is a sharing of meanings, which allows a PhD student to proceed as though the role of ICT in their research process is understandable and predictable. It could be considered as tacit knowledge through one's experiences of acting in the world (Inglis, Ling, & Joosten, 1999). As an example, the way in which one sees ICT being used to support learning in higher education depends on how the student conceives learning (Inglis, et al., 1999). One's thinking is often nourished by knowledge as well as by practices, and most human practices nowadays are affected by ICT.

Furthermore, this study aligns with one of the objectives of tertiary learning and teaching in New Zealand. The Tertiary Education Commission (TEC), is the body established by the New Zealand Education Act 1989 to provide leadership and strategic advice to the Ministry for Tertiary Education and Skills and Employment, promotes e-learning. E-learning is promoted as playing a vital role in strengthening New Zealand's tertiary education system to better meet the needs of learners (Ministry of Education, 2004). The TEC's position is that e-learning is a key enabler of an education system that will contribute to ensuring that is not only more fluid, but also more responsive to the needs of learners, education providers, and society as a whole. Such a position is part of a growing belief in New Zealand that e-learning is an aspect of the natural and crucial learning pathway for students in the knowledge society (New Zealand's tertiary eLearning portal, 2008).

3.4.2 The social and technological elements.

The cornerstone of the socio-technical framework is the joint optimisation of social and technical systems (Bostrom & Heinen, 1977a, 1977b; Chai & Kim, 2012), as illustrated in section 2.8. A joint optimisation could be represented in the current study by the link between a PhD student (the social part of the system) and ICT (the technical part of the system) in the process of producing a doctoral thesis, as shown in *Figure 3.3*.

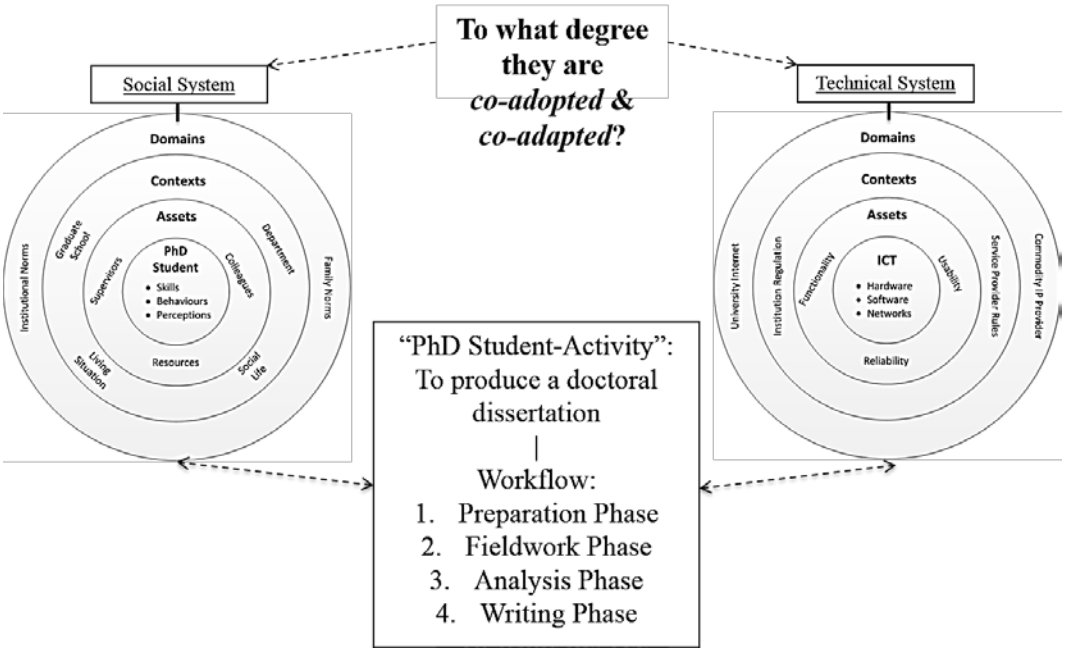


Figure 3.3. Socio-technical system in this study.

The nature of that link, as part of a socio-technical system, can vary depending on the way the relationship is established and developed through the goal-directed behaviours that aim to produce a doctoral thesis. Again, similarities can be seen with Esposito et al.'s (2013), learning ecologies of PhD e-researchers. In a socio-technical system, people, technology, and their environments engage in goal-directed behaviours (Butson, 2008; Walker et al., 2007), which result in productivity. The goal-directed behaviours in this relational sense generated a theoretical guideline for this study into how ICT is engaged in a PhD student's doctoral process. In this case, the goal-directed behaviours refer to the ways PhD students engage ICT to accomplish different tasks, such as in background reading for the research, conducting the research and writing the thesis. Productivity refers to the completion of a doctoral thesis at the end of the PhD process in an effective and efficient manner.

In order to understand the nature of the linked relationship, knowledge of the way in which PhD students' experience, engage and integrate ICT into their research practice is needed.

The approach of this study was to unpack the realities from the ongoing relationship between the social system (PhD students) and the technical system (ICT) in the doctoral research process, drawing on guidance from the socio-technical framework. The intention of this conceptual approach was to examine the impact each system has on the other, as well as to investigate how and if both systems are working in harmony. The social system, the technical system as well as how the combination of the social and the technical system work within the doctoral research process as presented in this study will be discussed below.

3.4.2.1 The social system.

A social system refers to entities or groups in definite relation to each other, to relatively enduring patterns of behaviour and relationships within social systems, or to social institutions (Bronfenbrenner, 1979). Norms become embedded into social systems in such a way that they shape the behaviours of actors or agents within those social systems. In the case of this study, the social structure was built around a PhD student with entities or groups related to the student and his or her social institutions. Norms become embedded into the PhD student's social system in the doctoral research process. The concentric circles in the *Figure 3.4*, which is an excerpt from *Figure 3.3*, represent the degrees of separation from a PhD student, who is in the centre of the circles. This representation, to some extent, follows Bronfenbrenner's (1979) representation of a socio-ecological system that studies the relationships with individuals' contexts within communities and the wider society. *Figure 3.4* has been modified from Bronfenbrenner's orginal diagram to incorporate elements within the concentric circles that were significant to the current study.

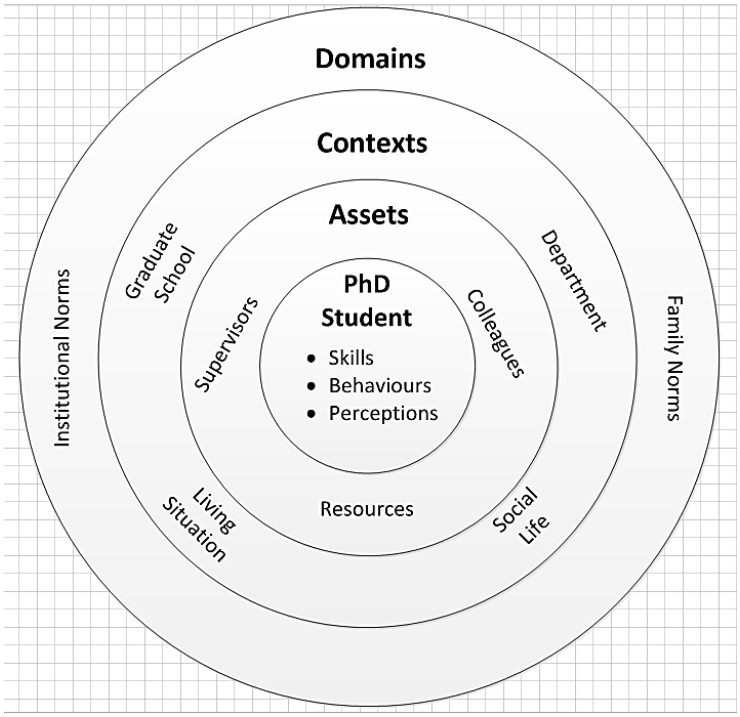


Figure 3.4. The social system.

Figure 3.4 thus represents how PhD students interact with each other and how their attitudes, actions, and opportunities are shaped by social structures (Bronfenbrenner, 1979). Instead of a four-layered socio-ecological system that consists of microsystem (individuals or groups who impact an individual the most), mesosystem (interconnections amongst the microsystem), exosystem (an individual's social setting) and macrosystem (cultures of an individual), the social system in this study is simplified into three layers that represents the similar ideas of the four. The social structures in the social system of the model are made up of assets (similar to microsystem), contexts (similar to exosystem), and domains (a combination of mesosystem and macrosystem). The basic foundation of the social system in this context is the assumption that a PhD student's skills, behaviours, and perceptions are shaped by all of the social structures shown in the centre of the diagram in *Figure 3.4*, that is, skills, behaviours, and perceptions. The social system is fourfold: individual PhD students belong to the domain; the domain adapts to the context; the context influences the assets around a PhD student; and the assets, or behaviour patterns, take on characteristics that are independent of the individual. The social structures in this sense imply a system of relationships that create the structure of the communities in which a PhD student lives. It is this structure that influences a PhD student's research life and characteristics. Structured sets of social relationships are the reality that lies beneath the appearance of "the free individual PhD student". For instance, despite an individual feeling as though he or she is acting with independence, institutional norms play a

large role in determining that PhD student's social structures and experiences. The institutional and discipline norms include the university and discipline climate, policies, and regulations and accepted behaviours, all of which affect a PhD student's research practices, passage through the doctoral study and eventual attainment of the degree.

As mentioned, the social system is centred on a set of core elements. They are:

1. Skills to do doctoral research. These skills include literacy, analytic, social, and technical abilities.
2. Behaviours which are expected to sustain the doctoral research process. These include time management, consumption and production of knowledge, as well as communication skills.
3. Perceptions about carrying out doctoral research. These perceptions include expectations, assumptions, and values of doctoral research and identity as a PhD student.

Around the PhD student in *Figure 3.4* is the circle of assets, which includes the individuals and the groups that have significant impact on the construct of "a PhD student" in achieving the goal-directed behaviours. They are supervisors – a primary supervisor and/or co-supervisor(s); colleagues – lecturers and peers in the department or research centre; and resources, such as the library. The next circle in *Figure 3.4* signifies the contexts a PhD student operates within to achieve the goal-directed behaviours in the doctoral research process. They various contexts include:

1. The Graduate School, or relevant institutional level unit/department, for providing oversight and policy advice in relation to doctoral research study. This entity represents the bureaucracy system.
2. The PhD student's academic department or research centre which creates the cultures of norm expectations in relation to the doctoral research study, and which has a considerable influence on PhD students skills, behaviours, and perceptions. This entity is an example of the academic network.
3. The living situation – referring to the student's broader environment – for framing a student's daily life in relation to his or her doctoral study. A student's financial situation is an example of this entity.
4. The social life for influencing a student's social circle in relation to his or her doctoral study. This is representative of peer interaction which can be manifested as peer pressure or support.

Finally in *Figure 3.4* is the circle indicating the domains, or the wider phenomena, influencing a PhD student's achieving the goal-directed behaviours in the doctoral research process. They are:

1. Institutional Norms – the "regulatory" operations and cultures within an institution play a role in shaping the PhD student's skills, behaviours, and perceptions, as well as those of the agents around the student, including doctoral supervisors and academic department.
2. Family Norms – the expectations, assumptions, social network, and the living situation within a family (of whatever form this may take) in shaping a PhD student's skills, behaviours and perceptions, and informing the agents around the student.

3.4.2.2 The technical system.

Figure 3.5, as the second set of concentric circles taken from the diagram in *Figure 3.3*, shows the components making up the technical system, a digital system or even a digital environment in support of human activity systems.

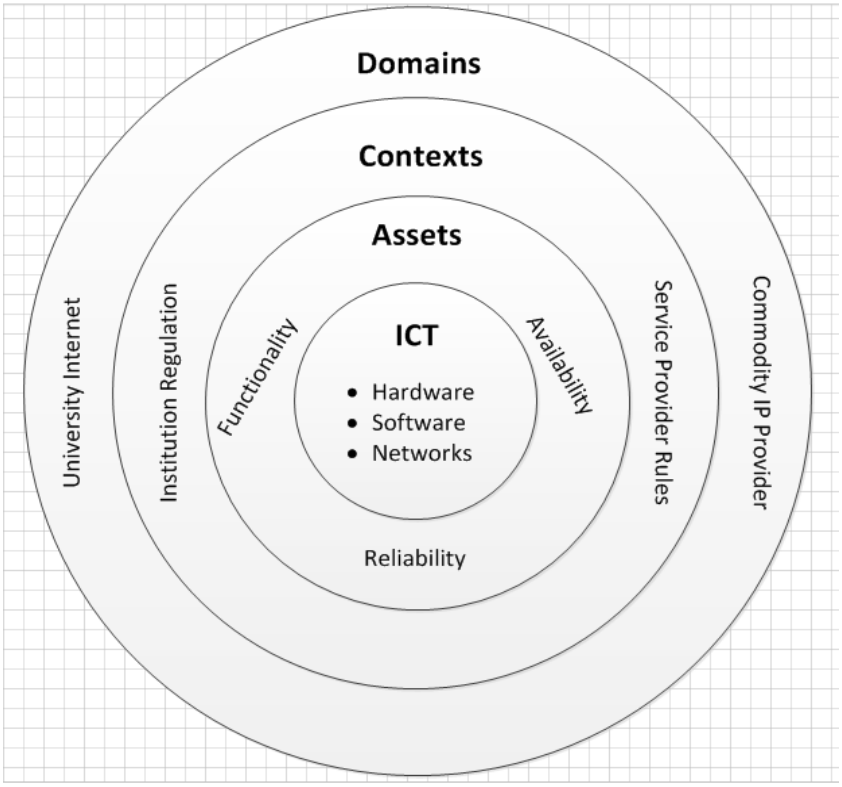


Figure 3.5. The technical system.

The technical system components define the substance of technology within a PhD student's process of conducting doctoral research, the ways it has emerged, the ways it could change and its relation to the student's social sphere. More substantively, it addresses the extent to

which technology is autonomous and how much force it has in determining human practice or social structure.

As shown in *Figure 3.5*, the technical system centres on ICT, the core element in doctoral research for a PhD student to achieve the goal directed behaviours. There is:

1. Hardware: the physical elements that constitute a computer system, for example, monitor and CPU.
2. Software: the set of machine-readable instructions that direct a computer's processor to perform specific operations, such as *Microsoft Office* and referencing applications.
3. Networks: the telecommunications that allow computers to exchange data, which is wireless and Ethernet.

Next in *Figure 3.5* is the circle of assets, which refer to the ICT features that have a recognised significant impact on unifying the people and the construct of "ICT" to achieve the goal-directed behaviours. These are:

1. Functionality, suggesting which ICT tool, device and/or network suits the doctoral research process.
2. Usability, entailing the ability of a PhD student to adapt ICT into his or her doctoral research.
3. Reliability, representing the ability of ICT to be adapted into the doctoral research process.

The third circle in *Figure 3.5* is the contexts, or the steady state for a PhD student to engage and integrate ICT within the operating environment to achieve the goal-directed behaviours in the doctoral research process. These are:

1. Institution regulations on ICT adoption in doctoral research, for example, the university internet setting.
2. Service provider for ICT engagement and integration by users/customers, that is, data usage.

Finally in *Figure 3.5* is the domains component, referring to the phenomenon that unfolds and changes the construct of ICT as well as the assets and the contexts in place for students to adopt ICT in order to achieve the goal-directed behaviours in their doctoral research. They are:

1. The university internet, which includes the access, the service, and the workstation provided for a student by the institution.

2. The Commodity IP Provider, which includes the alternative access, the service, and the workstation for a student to operate when he or she is not physically on campus.

3.4.2.3 Combining social and technical systems.

The social and technical systems are the initial presuppositions or starting points for the study. Each PhD student is defined by the combination of assets, context, and domain as described in *Figure 3.4* and *Figure 3.5*. This implies the existence of prior arrangements; not just a departmental association or a university norm, but a system of regulations, principles, procedures, and cultural practices that have emerged historically into a PhD student's social system, not just locally, but nationally, globally and most importantly, technologically.

From a social construction of technology perspective (Pinch & Bijker, 1984), human action shapes technology. The ways technology are used cannot be understood without understanding how that technology is embedded in its social context. Technological artefacts are culturally constructed and interpreted. From this perspective, there is not only flexibility in how people think of, or interpret, technological artefacts, but also flexibility in how these artefacts are adopted and adapted. The link or the relationship among a PhD student's social system, technical system and the task to be completed in the doctoral research process could be represented in the diagram in *Figure 3.6*, which is a simplification and exemplification of *Figure 3.3*. An investigation into that dynamic is suggested by the addition of the questions to the diagram.

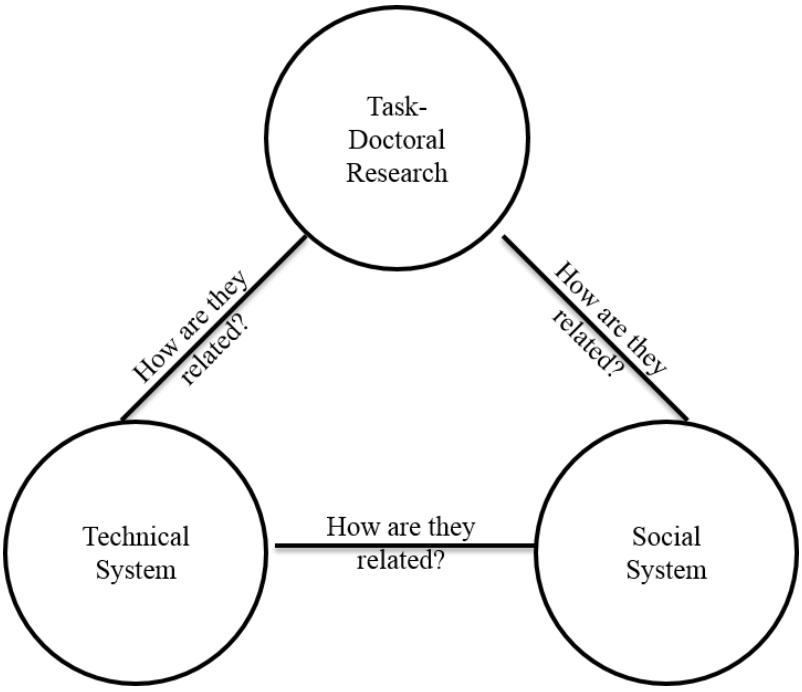


Figure 3.6. The relationship of the systems in the doctoral research process.

In this way, the core focus of the study in this thesis, which emphasises the exploration of the broader context of a university setting involving PhD students and their use of ICT in their task of producing a doctoral thesis, is captured.

3.5 Summary

This chapter has explained how a socio-technical framework, interpreted within a social constructivist perspective, was adopted to guide this study and how the processes of investigation were constructively grounded from, or on, the theoretical and conceptual framework. The next chapter will delineate the methods employed in the study, including details about the participants and the data collection and analysis.

Chapter 4: Methods

4.1 Introduction

This chapter outlines the data collection and analysis methods, based on the research design described in Chapter 3. The information about the participants is provided and the details about the data collection and the analysis techniques are presented along with the quality assurance measures put in place throughout the course of the study. The chapter concludes with a summary of the methodology used in this study.

4.2 Methods

This study adopted the interpretive, naturalist enquiry and analysis approach proposed by Guba and Lincoln (1989), from social constructivist perspectives. Following the ontological and epistemological underpinnings to the study, as well as the research approach based on these underpinnings (see section 3.2), the methods employed in this study were based on the intention to solve a "puzzle" in relation to a particular context. Three data collection methods were used to achieve the aim of the research, which was to investigate the beliefs and practices related to ICT and research processes held by students as they undertake their PhD study. Nine PhD students from the University of Otago participated and the focus of the investigation was the nature of their everyday socio-technical interactions. As highlighted broadly in section 1.1, the following specific objectives contributed to achievement of the study's aim:

1. To elicit the assumptions and expectations about ICT utilisation to support research processes held by PhD students at different phases of their study and from different disciplines.
2. To examine the degree to which ICT are utilised by PhD students in their research processes through an examination of their practice.
3. To compare the stated assumptions and expectations (from specific objective 1) and practices (from specific objective 2) with existing research studies reporting the role of ICT to support study.
4. To draw conclusions about the nature of ICT use by PhD students and to provide insights and implications for graduate supervision and research practice that will benefit institutions, disciplines, supervisors, and students.

4.3 Participants

A description of the study and invitation to participate (see Appendix 1) were sent via an email to all full time PhD students at the University of Otago, through the Graduate Research School, the graduate residential college (Abbey College), and the Division of Humanities as well as via a *Facebook* post on the private Graduate Community Group Page (Otago University Graduate Society). Thirty students who replied and showed their interest were invited to respond to a short questionnaire, generated by the researcher, with the intention of gaining some understanding of their self-perceived use of, and abilities with, computer technology. Similar to Blignaut and Els's (2010) computer literacy survey, the questions used for recruiting participants for this study were based on the student study context as well as their ICT use and ability.

The questions were:

1. My discipline background is
   a. Sciences
   b. Health Sciences
   c. Humanities
   d. Commerce

2. What is your current research phase? Circle as many as it suits.
   a. Preparation Phase
   b. Fieldwork Phase
   c. Analysis Phase
   d. Writing Phase

3. Please indicate the ratio (within 10) of how much your workload is according to the research phase that you have chosen in question two. For example, write 5:5 if you have a balanced workload between Analysis Phase and Write-up Phase.

   Preparation Phase ( )
   Fieldwork Phase ( )
   Analysis Phase ( )
   Writing Phase ( )

4. How do you rate your ability to use ICT?
   a. Expert and skilful

b. Fairly skilful

c. Not at all skilled

d. Not applicable

5. What is your selection of ICT devices, tools and networks for use in your PhD work? Please use the spaces to add others.

ICT Devices	ICT Tools	ICT Networks
e.g., laptops and tablets	e.g., SPSS and NVivo	e.g., Vodafone and University Network

The first three questions were included to give an indication of the distribution of the participants. Question 1 asked for the participants' discipline background as they related to the four broad areas of academic discipline that make up the organisational structure of the University of Otago, that is, whether the students were based in Commerce, the Sciences, Health Sciences, or Humanities. Question 2 asked about the participants' current research phase/s. A typical PhD programme at the University of Otago is full-time for three years. Ideally, it was aimed that, for this study, there would be a representation of participants from each broad discipline area as well as each research phase. Question 3 invited the participants to self-rate their perceived workload of the research phase/s they identified themselves to be in.

The last two questions determined the participants' self-reported ICT competence as well as their use of ICT in their research practice. Question 4 asked for a more general rating of participants' overall perception of their ICT skills, and question 5 asked the participants to list the devices, tools, and networks they were using for their daily research practice.

The questions were aimed at gathering some baseline data that would be compared with data about their actual practice (Datasets-2 and 3), later on in the study, as highlighted in section 2.6. In addition, the results of these five questions were used for the final selection of participants for this study.

Of the 30 students who replied to the initial invitation, 20 self-reported as average or expert computer users in response to question 4. The nine students with at least three items being listed for each category in question 5 were recruited. At this point in the study, pseudonyms

were assigned to each participant: Charles, Elizabeth, Jeremy, Mandy, Patricia, Sam, Shaun, Steve, and Xavier.

The selected participant group comprised a balanced distribution of broad discipline backgrounds: the Sciences *(n* = 2), Health Sciences (*n* = 2), Humanities (*n* = 2) and Commerce (*n* = 3); and PhD research phases. For the purposes of consistency, for this study, "Early" referred to the broadly described preparation phase, while "Mid" referred to the fieldwork and/or analysis phase and "Final" referred to the process of writing up the thesis and nearing the time of submission of work for examination. A well-balanced distribution was displayed in this regard: Early Phase (*n* = 3), Mid Phase (*n* = 3) and Final Phase (*n* = 3).

Question 3 explored how the students used their computers for their doctoral research (see Table 4.1). Two of the nine – Elizabeth and Xavier – felt they took a balanced approach to computer use for their doctoral research. While Elizabeth reported equal workload in preparation of her research and her fieldwork, Xavier claimed equal workload in preparation and data analysis of his research. Four participants only used their computer for the single task of their doctoral research. They were Jeremy, Mandy, Patricia, and Sam. Both Jeremy and Mandy were in the writing phase, whereas Patricia and Sam were in the preparation phase. The other three, Charles, Shaun, and Steve, stated that they were more likely to use their computer for one of the other purposes. Forty-five percent of Charles' workload was on each of his fieldwork and analysis, with the remaining 10% on preparation of his research. Much of Shaun's workload (70%) was on preparation, with another 30% on his fieldwork. Lastly, Steve's workload was mostly in the writing phase (70%), with 20% of data analysis and 10% of fieldwork.

Table 4.1: *Participants' Self-reported Computer Use (Q3), According to PhD Phase*

Participants/ *(pseudonyms)* Discipline Background	Percentage (%) of the workload		
Charles (Science)	Preparation (10%)	Fieldwork (45%)	Analysis (45%)
Elizabeth (Health Science)	Preparation (50%)	Fieldwork (50%)	

Participants/ *(pseudonyms)* Discipline Background	Percentage (%) of the workload		
Jeremy (Humanities)	Writing (100%)		
Mandy (Humanities)	Writing (100%)		
Patricia (Science)	Preparation (100%)		
Sam (Commerce)	Preparation (100%)		
Shaun (Science)	Preparation (70%)	Fieldwork (30%)	
Steve (Health Science)	Fieldwork (10%)	Data Analysis (20%)	Writing (70%)
Xavier (Commerce)	Preparation (50%)	Data Analysis (50%)	

Question 4 asked students to self-rate their ability in using computers. All nine selected participants reported their ability as "fairly skilful". Regarding use of specific ICT devices, tools, and networks (question 5), all nine participants generated their individual lists.

All nine participants' questionnaire replies were summarised and the data were assembled in tables and are presented in Appendix 2. As already mentioned, the questionnaire replies were kept as a preliminary or baseline dataset for basic comparison and contrast once the study was underway.

4.4 Data Collection

Data collection started on 1st October 2013 and ended on 31st March 2014, a six month period. Contrary to the typical data collection methods employed in most studies on student use of

ICT in higher education, as emphasised in section 2.6, both perception and actual practice data-gathering methods were employed in this study in order to explore the role of ICT in PhD students' research practices. Having both perception and actual practice data simultaneously challenges the idea of correspondence between representation (perception) and the "real" (actual practice). What is important is not correspondence, but the adequacy of the phenomena relative to the observed context to provide explanation (e.g., the understanding of the practice) and a predictive capability (i.e., from the understanding of the practice). It can never be proven whether representations (perception) succeed in exact correspondence, but it is possible to move towards correspondence of the real. In this respect, the methodological outcomes sit within the social constructivist stance, and thus align with the ontological and epistemological assumptions and the research approach that was based on these underpinnings (see section 3.2).

The study sought to elicit students' points of view by asking them to engage in self-monitoring techniques through computer activity capture, which formed Dataset-1, and a participative drawing method, which became Dataset-2. These approaches offered a glimpse into study behaviours that are normally concealed. These two datasets formed the practice-related data for this study. At the same time, perception data were gathered through individual and group discussions – Dataset-3 – as a way of gaining insights into the participants' expectations and assumptions about ICT use in their doctoral research. The aim was to reveal whether the students' actual practice was influenced by perception or whether the perception informed actual practice. Whichever way it was, it was of interest to know how this ongoing interaction worked for a PhD student using ICT in his or her process of undertaking doctoral research. In addition, in conjunction with the individual and group discussions as part of Dataset-3, photographs of the participants' work areas were taken. The photographs worked as stimulants to discussion, with a view to "seeing through" the physical situations through gathering reflections on behaviours and practices.

The timeline for the recruitment and data collection periods are illustrated in *Figure 4.1*. Details about each of the major data collection methods follow.

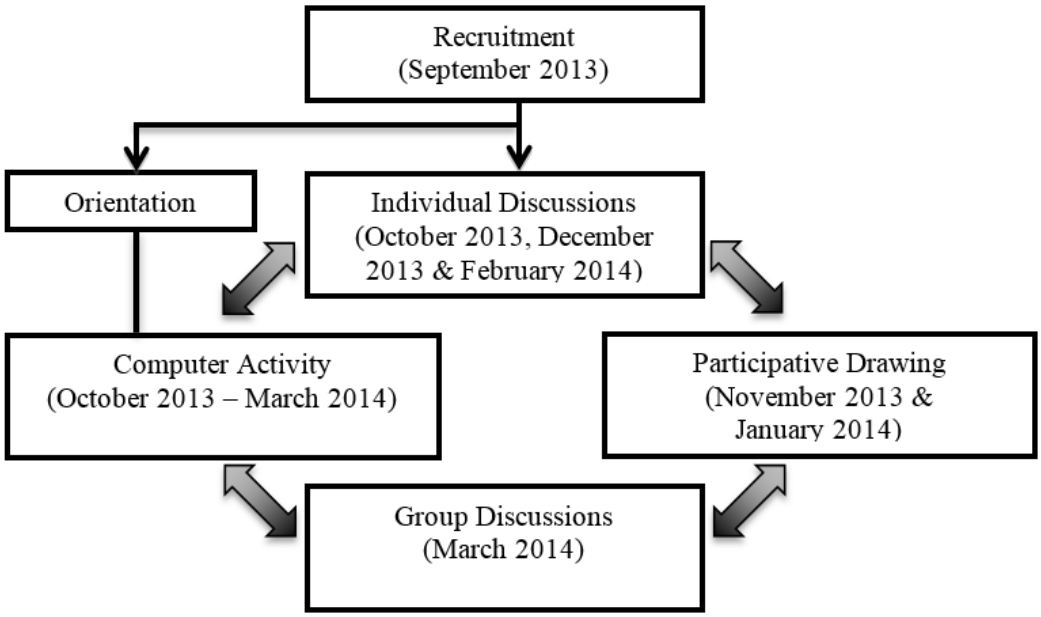


Figure 4.1. The recruitment and data collection timeline in this study.

4.4.1 Dataset-1: Computer activity data.

The computer activity data, Dataset-1, was a core dataset. This dataset comprised intentionally captured real-time data, tracking what student participants did daily and monitoring their ICT use as part of their research practice in relation to their work towards thesis production. These data were gathered using a free software programme, *ManicTime*, which is known as "personal time management software" for logging and tracking work hours (Mininday, 2009). Participants were given a free copy of the software, and knew that would record only the date, time, duration, and type of computer programmes used as well as the date, time, and duration of the websites they visited over the six month period of the data collection phase of the study.

ManicTime has the ability to incorporate data from cloud storage into analytics. *ManicTime* resides in the background of the computer reducing its intrusion on users' normal computer use. It does not record the content of programmes or websites. The data collection was thus not reliant on the students keeping records, and consequently, it would yield more accurate information than could be gained from asking students about their computer usage. In these ways, the computer activity data captured from the software adequately reflected the participants' research practice involving their computer.

A session providing an orientation to *ManicTime* was facilitated by the researcher at the start of the study (September 2013) – see *Figure 4.1* – with the intention of informing and training

the participants in the purpose and use of the software. Participants had full control of the software, including the ability to turn it on and off and to delete the details of captures. All the participants attended the orientation session. The computer activity data recorded the programmes and web services that participants were using on a regular basis. Summary reports on data being gathered were calculated instantly and available for viewing by the participants by clicking on an icon on the task bar. The software used the interface shown in *Figure 4.2*, *Figure 4.3*, and *Figure 4.4*.

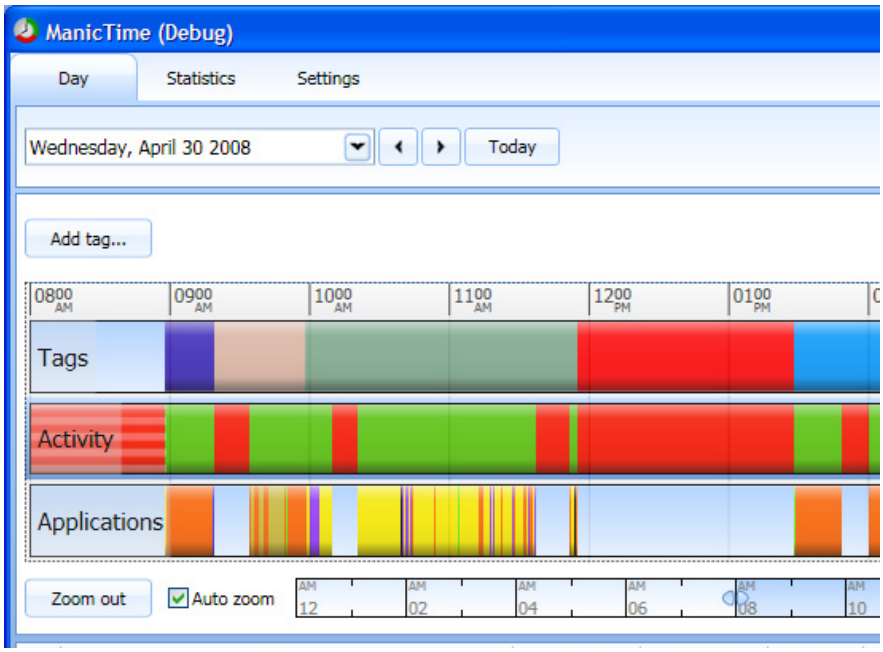


Figure 4.2. *ManicTime* interface: Computer activities are tracked based on the time of the day (Mininday, 2009).

Figure 4.2 shows the *ManicTime* interface and how computer activities are tracked based on the time of the day. In this example, the interface shows the computer activities tracked on Wednesday 30th April 2008 from 8:00 a.m. onwards. By dragging down the date and day column, the computer activities on other days could be reviewed.

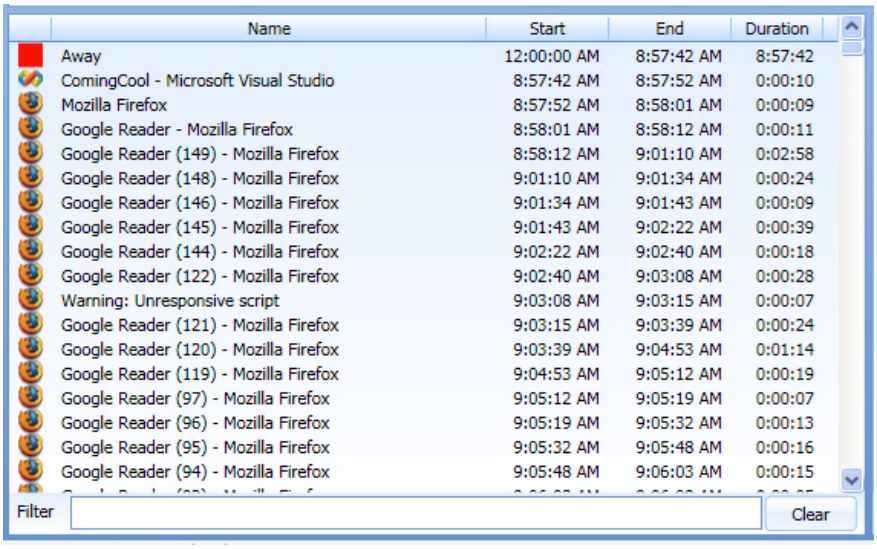


Figure 4.3. *ManicTime* interface: The starting and the ending time of each computer activity is recorded (Mininday, 2009).

Figure 4.3 illustrates how *ManicTime* displays the starting and the ending time of each computer activity that is recorded. For example, the application *ComingCool – Microsoft Visual Studio* shown in *Figure 4.3* was only used for 10 seconds from 8:57:42 a.m. to 8:57:52 a.m.

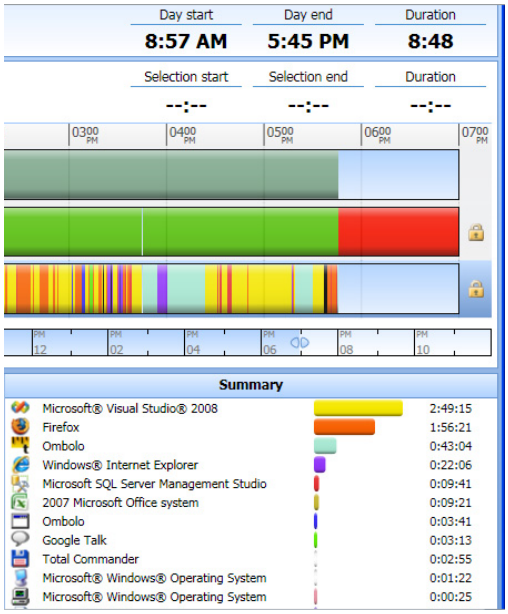


Figure 4.4. *ManicTime* Interface: A summary of each computer activity is calculated each day (Mininday, 2009).

Finally, *Figure 4.4* shows how *ManicTime* generates a summary of computer activity in terms of time in hours of use per activity across each day. For instance, this interface shows that the

most used application on the day was *Microsoft Visual Studio 2008*, which was used for about 2 hours and 50 minutes. On the top right corner, the total duration the computer device was used is displayed, which in this example, was 8 hours and 48 minutes.

ManicTime thus provided a detailed computer activity tracking facility. Live data are presented in both tabular and graphic forms. These summary displays include the most used applications, documents being accessed the most, and overall computer usage within a certain duration (see *Figure 4.5*).

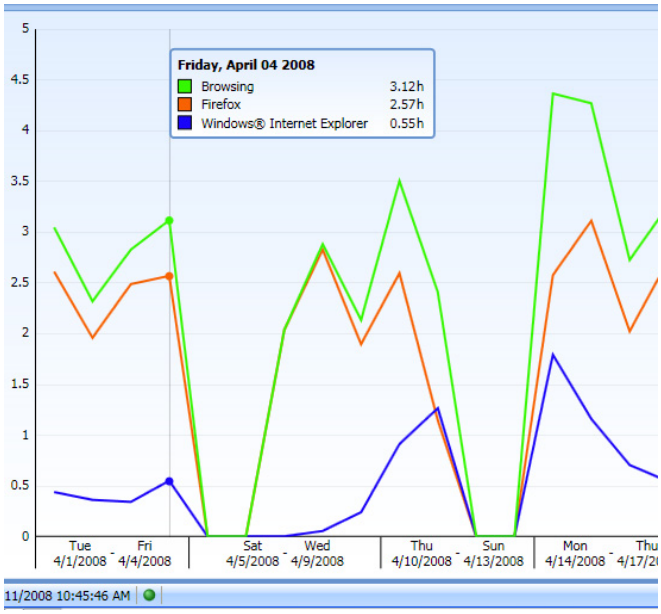


Figure 4.5. Computer usages by duration (Mininday, 2009).

In this case, browsing activities recorded 3.12 hours (3 hours and 7.2 minutes) with *Firefox* being used for 2.57 hours (2 hours and 34.2 minutes) and *Windows Internet Explorer* covered the remaining 0.55 hour (33 minutes).

The core benefit of using *ManicTime* for this study was its function as a personal time-tracking tool, thus providing monitoring at a rudimentary level. Other software programmes reviewed for the study, while more comprehensive in their data capture, were defined as surveillance packages. These types of programmes are often covert in nature, recording every keyboard activity, such as passwords and online banking information. *ManicTime*, on the other hand, is overt in that users have access to the software from the task bar and the ability to delete any of the records. The data captured are less sensitive, in that *ManicTime* only tracks the software programmes that are being used, such as *Microsoft Office* or browser applications, the websites visited through capturing the Uniform Resource Locators (URLs)

and the documents that are accessed, for example, “Chapter 1.doc”. At the same time, it records the duration of these activities.

The researcher extracted these data about computer activities from each participant’s computer at the end of six months. The analysis method of this set of data will be discussed in section *4.5.1*.

4.4.2 Dataset-2: Participative drawing data.

A three-tier participative drawing process was included as one of the methods to identify the patterns of behaviours from a student participant’s reflections. The reason for gathering data through this means was based on the rationale of that thoughts typically occur as non-verbal images even though they are often expressed verbally (Birdwhistell, 1970; Burgoon, Buller, & Woodall, 1989; Knapp, 1980; Mehrabian, 1971; Seiter, 1988; Weiser, 1993). Similar to Dataset-1, where practices (the captured computer activities) may differ from perceptions, the way in which thoughts occur in drawings may be very different from the way in which they are communicated in an interview, for instance. In the current study, the drawing allowed the student participants to share their thoughts about ICT in the process of undertaking doctoral research and allowed the researcher to observe and question them, as the participants talked about their drawings. It was not the representation in the drawing that was the most important part of the data, but the construction of ideas as were revealed through the talk alongside with the drawing. This dataset provided a degree of adequacy in explaining the nature of the phenomena being explored. It was important to enable participants to represent their images in non-verbal terms, thus bringing the interpretation “closer” to the state in which thoughts occur and thus both the researcher and the participants were able to learn more about them (Birdwhistell, 1970; McKim, 1980; Wetton & McWhirter, 1998). In short, the ambiguity inherent in the drawings from the discussion sessions encouraged sharing and dialogue between the individual participants and the researcher. The combined use of the visual and verbal communication channels enabled the reader/viewer, that is, both the researcher and the participants, to accept “multiple viewpoints and voice even when they appeared to conflict with one another” (Johnston, 2004, p. 432).

The details of the participative drawing data collection are now outlined. It comprised a three tier/phase structure.

4.4.2.1 Participative drawing phase 1.

In November 2013, two months into the data-gathering phase of this study (see *Figure 4.1*), all the participants were asked to draw a mind map, a diagram or any conceptual structure, based on their perspectives about the doctoral research process. They were then asked to insert ICT devices, tools, and networks into the process. The participants undertook the task in their own time in an unsupervised setting, and were given a week to complete their drawings. Including written text with the drawing was optional. An example of one participant's drawing is presented in *Figure 4.6*:

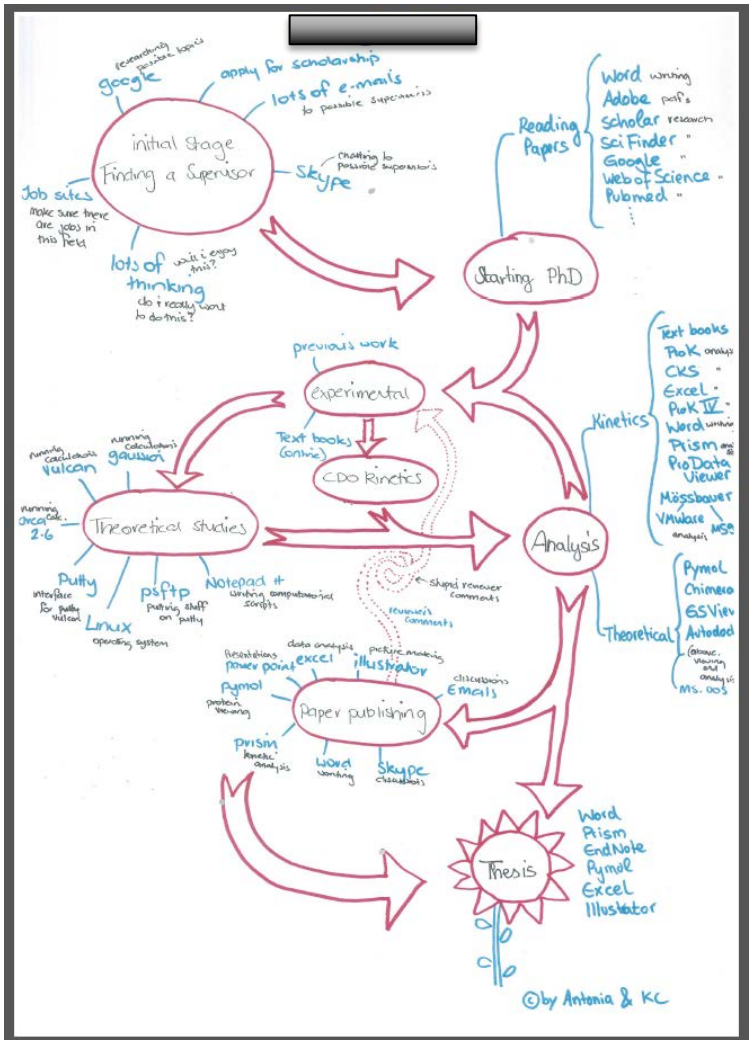


Figure 4.6. Charles' drawing.

After completing the drawing, each participant participated in an individual discussion session with the researcher. The discussion focused on the individual's drawing. Stimulus questions were used to prompt discussion and included, for example:

1. Who introduced this way of undertaking doctoral research to you?

2. What is your current research phase?
3. When and how did you decide on the ICT devices, tools and networks to use at each research phase?
4. Why would you follow this process as presented in this drawing?
5. What would make you change your perspectives on your process of carrying out doctoral research with these ICT devices, tools and networks?

The questions were aimed at eliciting responses that made some link to the study's research questions (see section 1.1). They were used to explore the participant's thinking about what he or she was trying to represent through the drawing. As the participant and the researcher discussed the drawing, the participant and the researcher made modifications as a way of clarifying the researcher's interpretation of the participant's perceptions as represented in the drawing. Different coloured pens were used for the modifications, as shown in the example in *Figure 4.7*.

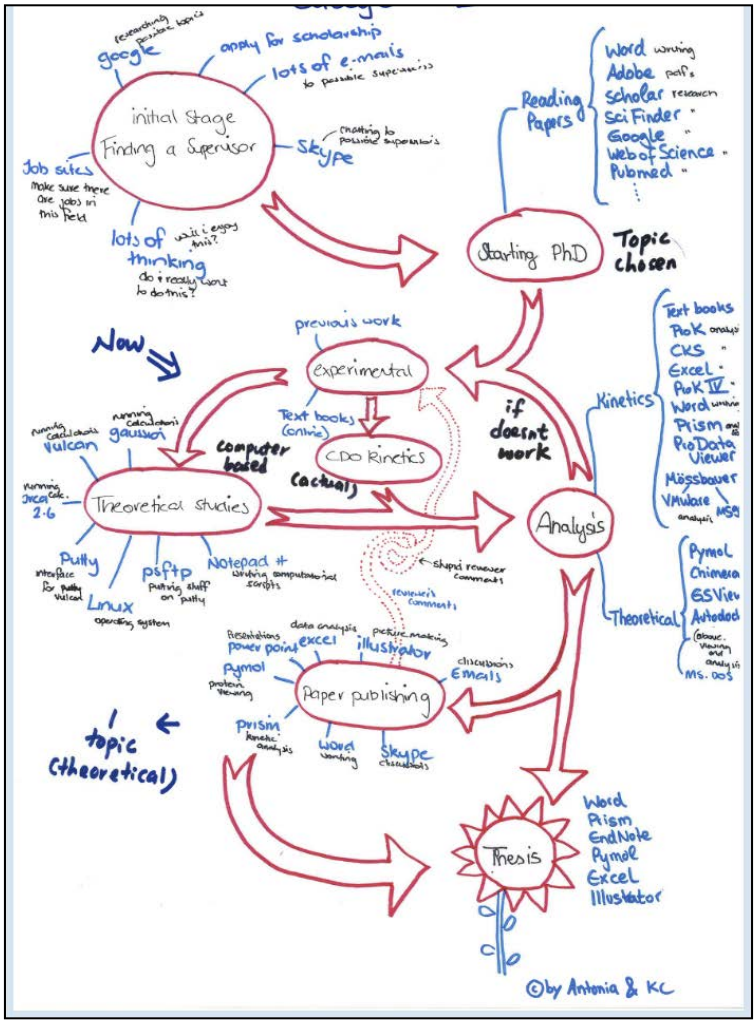


Figure 4.7. Markings on Charles' drawing – modifications to original drawing in *Figure 4.6*.

In this case, the bold black markings represent the researcher's notes and the bold blue markings signify those of the participant, Charles. The modified drawing was then scanned and saved on the researcher's password-protected computer for later analysis. In addition, this discussion session was audio recorded.

The discussion meant that the interpretation of the meaning behind the drawing was not made solely by the researcher, but through the unavoidable conflict and disagreement as the perspectives and interpretations of researcher and participant reached parity – the hermeneutic dialectic process (Guba & Lincoln, 1989). This process of co-constructing understandings (Erickson, 1986, 1998) as mentioned in section *3.2.2*, resulted in consensus of interpretation about the drawing's meaning between the researcher and the participant.

4.4.2.2 Participative drawing phase 2.

In January 2014 (see *Figure 4.1*), individual participants were invited to a second discussion. This time the focus of the discussion was a drawing of a diagram that the researcher had sourced from an experienced academic. The stimulus diagram appears in *Figure 4.8*. The drawing depicted the processes of undertaking doctoral research, from the perspective of the academic who is also a supervisor of graduate students. The reason behind this phase was to stimulate the participants' further thinking about their understanding of the doctoral research processes, by having to respond to a diagram prepared by someone who was an experienced supervisor, and hence "an expert" of sorts. This would, in a way, challenge the participants through confronting them with a diagram which they may have agreed or disagreed with. This process again echoed the hermeneutic dialectic process (Guba & Lincoln, 1989) because it offered a possible alternative viewpoint from their own, and thereby prompted them to either affirm or reject the alternative and to further articulate, clarify or restate their own view.

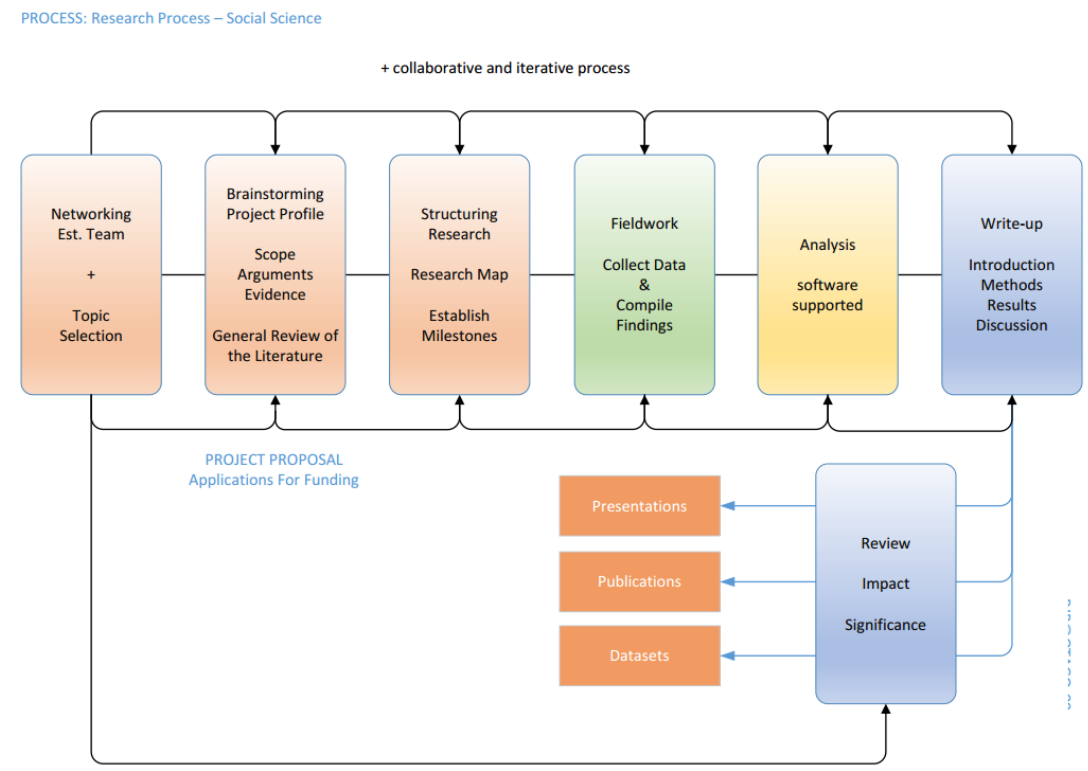


Figure 4.8. The stimulus diagram.

This stimulus diagram brought factors external to the discussion situation into view, prompting response to "not now" moments, "not here" events and "not present" actors (Törrönen, 2002, p. 348). Further, participants' responses to the drawings' meanings were based on their knowledge of the world and on what has been useful to them in the past. By doing this, they were likely to alter what no longer "works". The stimulus diagram discussion used some or all the following questions as prompts, depending on the individual discussion:

1. To what extent is this drawing based on your understanding of doctoral research process?
2. When did you decide your own process of undertaking doctoral research?
3. What would make you accept or reject the process of carrying out doctoral research as shown in this drawing?
4. Why do you think there is no list of ICT devices, tools, and networks attached to each research phase on this drawing?
5. How are your drawing and the stimulus drawing similar or different, apart from the absence of the list of ICT devices, tools, and networks being attached to each research phase?

Similar to the participative drawing phase 1, there was a production of meanings (interpretations) generated. The discussion thus enabled a process of construction and co-construction of ideas between the researcher and the participant. Notes made during the discussion were added to the diagram as illustrated in Charles' example in *Figure 4.9*.

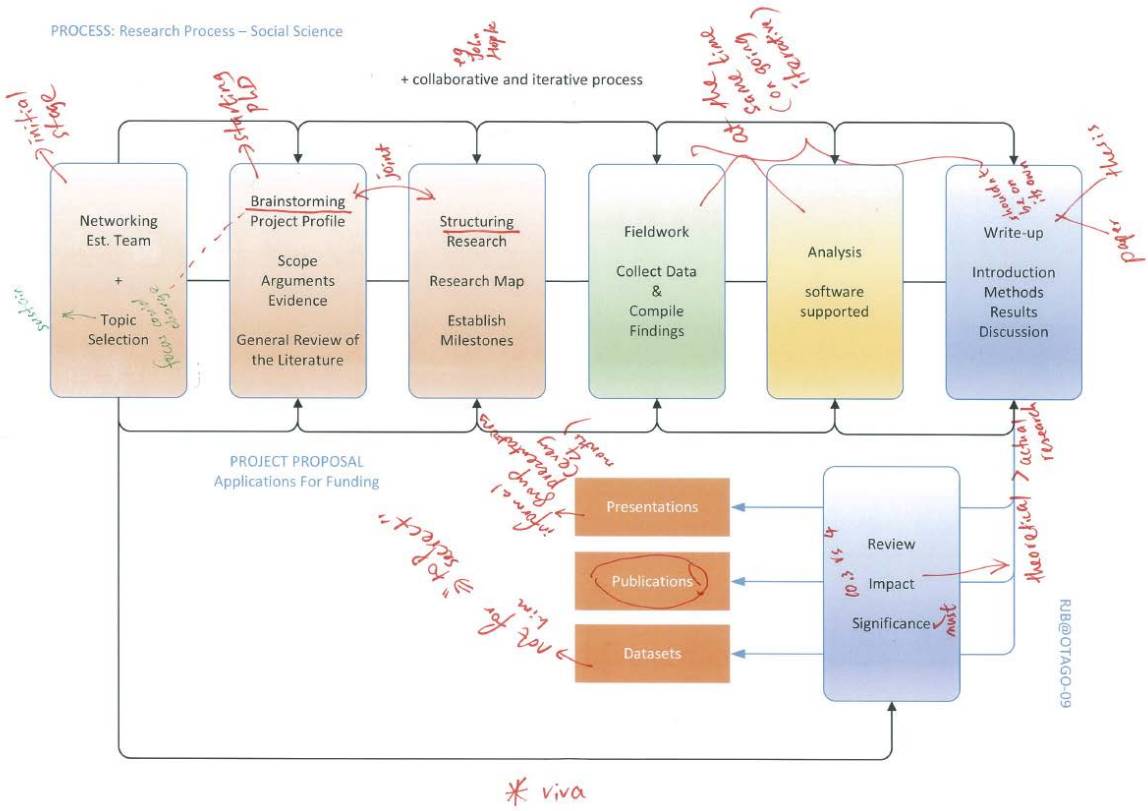


Figure 4.9: The co-construction of ideas on the stimulus diagram between the researcher and the participant (Charles).

In *Figure 4.9*, the red markings were ideas that were generated between the researcher and Charles in the discussion session. The green markings in the Networking Est. Team box were the notes from Charles. The annotated drawings were scanned and saved, and the discussion session was audio recorded for later analysis.

In short, although spoken language was an indispensable part of both participative drawing phases, they were linked directly with specific non-verbal visual images as well, to provide stimulus materials for the discussions (Birdwhistell, 1970; Blackwell, 2001; Crilly, Blackwell, & Clarkson, 2006; Goodman, 1969). The combination of spoken language generated by the discussion and the visual language provided by the drawings offered the opportunity for participants to convey deeper and more varied internal representations or meanings (Birdwhistell, 1970; Dondis, 1973; Hervey, 1982; Kjorup, 1991).

The analysis of the data from participative drawing phases 1 and 2 will be discussed in section *4.5.2*.

4.4.3 Dataset-3: Interactive data.

4.4.3.1 Individual discussions and photographs.

The regular individual discussions incorporating photographs of the students' work areas were aimed at identifying the participants' perceptions and the behaviours in relation to ICT use. The photographs were used to enhance the understandings that were being developed through the individual discussion sessions, and as a prompt to discuss participants' behaviours when engaging with ICT, ways of using ICT as part of their research practice, and non-verbal behaviours as they interacted with, and used, ICT.

As well as a data gathering process, Dataset-3 supported the development of a closer relationship between the researcher and each student participant. In this way, the students were involved in a researcher-participant role, which is an important aspect of the methodological perspective underpinning this study. The regular individual discussions thus enhanced the hermeneutic dialectic process (Guba & Lincoln, 1989) and facilitated the co-construction of meanings given to the images of reality experienced and described. Assertions about student participants' perceptions and behaviours were made by the researcher throughout the process and then checked and rechecked, affirmed, refined, or modified in the light of further engagement with the participants through the regular discussions. With these, the researcher was able to come to an understanding of the participants' understandings of their ICT use in doctoral research processes and was able to report on those understandings in a way that they, researcher and participants, agreed upon. Thus, in this hermeneutic dialectic process (Guba & Lincoln, 1989), the researcher and participants engaged in the research in an educative and mutually beneficial way: the researcher sought to understand the way the participants were viewing their world of ICT and doctoral study, and the participants came to understand their own views and perceptions more explicitly.

In all, the participants were invited to attend three individual informal discussions during the six-month data collection period: in October 2013; in December 2013; and in February 2014 (see *Figure 4.1*). The aims of the individual informal discussions carried out in October 2013 were to provide an opportunity for the researcher and the participants to build rapport in order to get to know each other. In this relationship, the researcher made observations through the

participants' spoken descriptions in relation to their initial thoughts on doctoral process as well as ICT use in undertaking this process.

In December 2013, a second individual discussion was held. In this session, attention was drawn to the participants' social and technical systems (see section *3.4.2*). The researcher, together with each participant:

- reviewed the participant's current phase of research;
- followed up on the previous discussion in terms of clarifying developing understandings about undertaking doctoral research;
- described and clarified each participant's social and technical systems;
- identified relationships between the participant's social and technical systems;
- jointly constructed the role of ICT in the doctoral research process.

The third informal discussion was held in February 2014, after preliminary analysis of the data from the two practice-related data sources, that is, computer activity data (section *4.4.1*) and the participative drawing data (section *4.4.2*), had been completed. The preliminary outcomes of the observational data from practice-related datasets were used as a way to probe the participants':

- recall of particular events across the period of data capture;
- justifications of their choice of ICT use at the time;
- reflections on these experiences;
- use of ICT to support their doctoral research; and
- approaches to their relationship between the social and technical systems in their research process.

With the participants' permission, every discussion was audio recorded, and then transcribed to produce verbatim records of the conversations. The researcher also gained permission from the participants to make use of the photographs in the study. The analysis of the data from these individual discussions as well as photographs will be discussed in section *4.5.3*.

4.4.3.2 Group discussions.

Group discussions were included in this study to provide an opportunity for individual participants to share their views on the details of the role of ICT in relation to doctoral research process. People describe themselves with the actions and details of everyday life (e.g., what these actions mean), as well as how people interact with each other. People attach

meanings to actions, and then behave according to their subjective interpretation of these actions (Erickson, 1986). For example, PhD student participants might look for the symbolic meaning that people around them (i.e., other student participants in the group) develop and rely upon in the process of discussion. The ways in which a student interprets the actions of others, develops a self-concept or self-image, and acts in terms of meanings (Denzin & Lincoln, 1994). In this way, the group discussions served as an instrument to allow participants to share their ideas on their perspectives of doctoral research as well as the roles of ICT in the research process, through interpreting, describing, and expressing understandings of their subjective realities.

Group discussions were conducted at the end of the data collection period in March 2014 (see *Figure 4.1*). The discussions included the participants' selection of ICT, their level of competence, and their experiences of working on their research with various ICT. The participants were divided into three groups according to their progress through their candidature: 1. Early (n = 3); 2. Mid (n = 3); and 3. Final (n = 3).

The following are the examples of the questions that focused the group discussion:

1. Would you like to share with us what was particularly good about your experience in this research process thus far?
2. What do you notice from your colleagues' research practices?
3. How do you feel when you see your colleagues doing things differently?
4. Who in particular has influenced you to use [a certain ICT device/tool/application]?
5. What are the pros and cons of using [a certain ICT device/tool/application]?
6. Looking back, do you find anything missing from your research process?
7. If a future student asked you for advice, what could you recommend might work well for this particular process of doctoral research?

The questions guided the discussion with the expectation that the participants would take a reasonable degree of control and leadership. Due to unforeseen circumstances, one participant in each group sent their apology on the day. Consequently, a combined doctoral research phase group was formed. There were then four group discussions in total: 1. Early (n = 2); 2. Mid (n = 2); 3. Final (n = 2); and 4. Combined (n = 3).

Through this, understandings were developed about the participants' expectations and assumptions, as well as practices of the participants in relation to their ICT use with other PhD colleagues who were either in the same or different research phases as they were. With

this, each participant's assumptions, expectations and the reasons for behaviours from the perspective of each participant could be determined as well as agreed upon as part of the hermeneutical dialectical process. Similar to the individual discussions described in section *4.4.3.1*, with the participants' permission, every group discussion was audio recorded and transcribed to produce verbatim records of the conversations. The group discussion data were then analysed.

In summary, the practice-related data captured through Dataset-1 (computer activity data), Dataset-2 (participative drawings), and Dataset-3 (the interactive data gathered through the individual and group discussions as well as the photographs) aimed to establish a comprehensive and holistic view of PhD students' use of ICT in their doctoral research process.

4.5 Data Analysis

Data analysis processes are now presented. To achieve the alignment with the research design as described in Chapter 3, the theoretical and the conceptual perspectives were applied throughout the process of data analysis for each dataset. As section *4.4* indicates, there was a consequential overlap between the data collection and the data analysis phases. Iterative processes of the reviewing occurred alongside the emergence of findings, as well as the development of areas for further discussion and themes. Assertions emerged or unfolded from interactions among the data and the actions, as part of the hermeneutic dialectic process (Guba & Lincoln, 1989) between the researcher and the participants.

4.5.1 Analysis of Dataset-1: Computer activity data.

As illustrated in section *4.4.1* at the end of March 2014, the sixth month of the data collection period (see *Figure 4.1*), an individual meeting was scheduled with each of the nine participants to extract their computer activity dataset. By clicking on the "Tools and Settings" tab on *ManicTime*, all the computer activities generated from 1st October 2013 to 31st March 2014 in SDF (a database file) format were saved to a USB stick. The files were then transferred to the researcher's computer to extract all the figures and tables. As explained in section *4.4.1*, these figures and tables provided data on daily duration, the most used applications, and the most accessed documents yielded by *ManicTime*. The tables were exported to *Microsoft Excel* for data cleaning purposes, that is, to remove any irrelevant data and any error caused by corruption in data transmission.

In *Microsoft Excel*, the tables were rearranged and combined according to duration each day, the 50 most used applications, and the 50 most accessed documents individually as well as for the whole cohort in relation to the duration being recorded (unit = hour). Fifty was chosen because *ManicTime* could generate a maximum of 50 most used applications and the most accessed documents only. The software application used for the analysis of this dataset was the *Statistical Package for the Social Sciences* (*SPSS*) version 22. In addition to its role as a research analysis tool, *SPSS* was used to manage the data, including case selection, file reshaping and for creating derived data, as well as for data documentation. The "cleaned" tables were shifted from *Microsoft Excel* to *SPSS* for calculation and generation of computer usage patterns in graphs, according to the individual's as well as the cohort's computer use each day (duration), the 50 most used applications and the most accessed documents. The summary of the computer activity data analysis is shown in *Figure 4.10*.

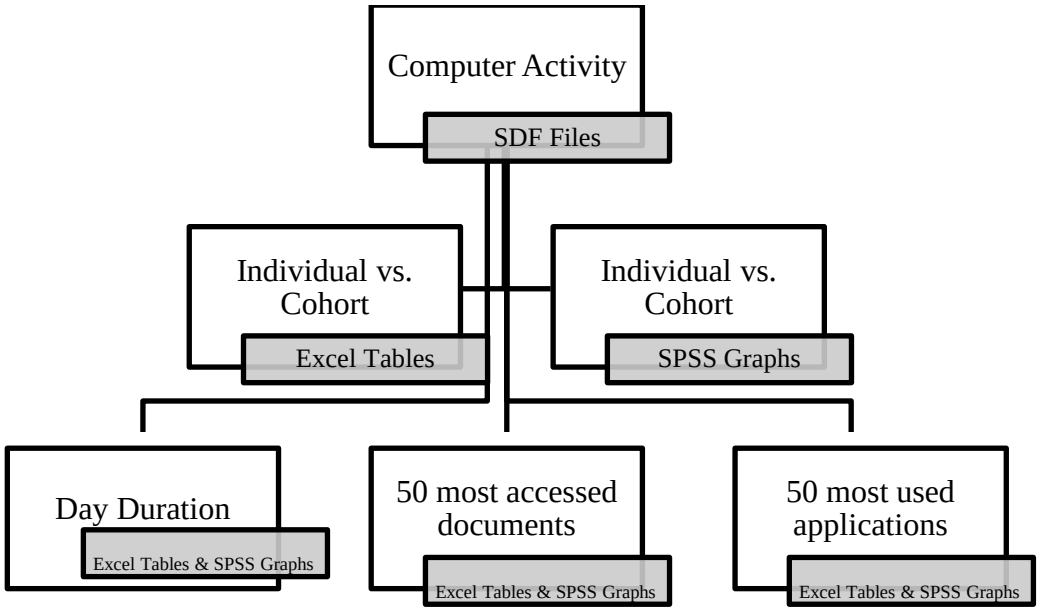


Figure 4.10. The process of analysis for Dataset-1.

As shown in *Figure 4.10*, the analysis focused on the 50 most used applications and the 50 most accessed documents. The dataset was filtered into two categories titled Discipline Background and PhD Phase. Discipline Background refers to the participants' broad academic disciplines as explained in section 4.3, namely Humanities, Commerce, the Sciences and Health Sciences. PhD Phase is the participant's phase of doctoral research: Early Phase, Mid Phase and Final Phase. The 50 most used applications and the 50 most accessed documents were divided according to two main applications on any computer device, that is, client-side applications, for example, *Microsoft Office* and browser-based applications, such as library

database or *Google*. Client-side applications refers to all the built-in application programmes on the participants' computers and/or laptops. The use of these applications and documents were discussed with the participants in February 2014 (*see Figure 4.1*) as well as after March 2014 via emails, on the basis of whether they were used for doctoral research purposes or not.

At the same time, since *ManicTime* generates computer activities based on the calculation of time (see *Figure 4.2 – Figure 4.5*), the average daily computer use of the participants in hours was calculated across the six months' computer activity capturing period. The various starting hours were categorised as early starters (00:01 – 07:59 a.m.), regular starters (08:00 – 10:30 a.m.), late starters (10:31 – 11:59 a.m.) and very late starters (12:00 noon – 12:00 midnight). The starting times of the participants' days were matched with their discipline background as well as their PhD phase.

The results of the computer activity or Dataset-1 analysis are presented in Chapter 5.

4.5.2 Analysis of Dataset-2: Participative drawing data.

Analysis of the drawings was undertaken through a three-tier process as in the data collection process for this dataset (see section *4.4.2)*.

4.5.2.1 Participative drawing phase 1.

Analysis of this dataset took the form of a relatively straightforward thematic coding analysis. Specifically, the general strategies of coding very like a Constructivist Grounded Theory (Charmaz, 2006) approach were employed. The basic concepts of coding made use of the qualitative analysis software, *NVivo*, to facilitate a systematic, iterative approach. *NVivo* was applied in the use of memos, data storage, to track research progress, and data analysis. The process of the analysis for participative drawing phase 1 is summarised in *Figure 4.11*.

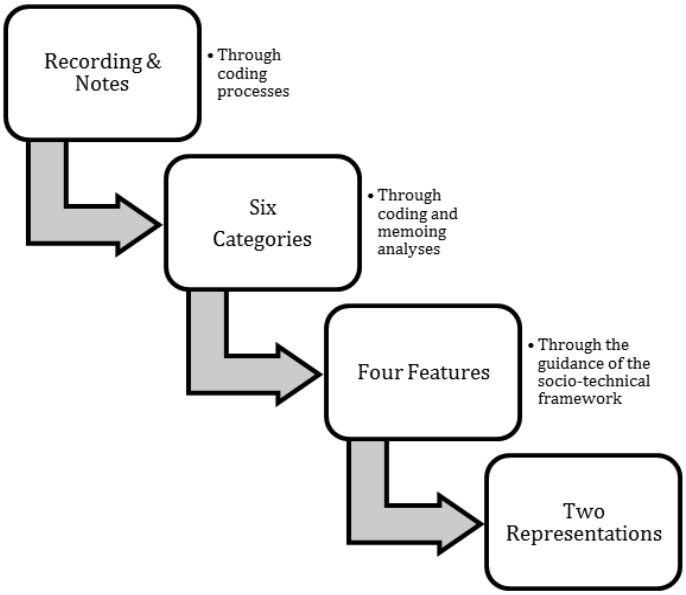


Figure 4.11. The analysis process for participative drawing Phase 1.

As indicated in *Figure 4.11* (Recording & Notes), the analysis began with listening to all the audio recorded discussion sessions, reading of all the notes taken by the researcher as well as the texts or markings on the participants' drawings, as shown in the example in *Figure 4.7*, to gain an overall sense of the data. Listening and reading led to the identification of an initial code list based on the participants' meanings of the role of ICT in the doctoral research process was. Using the example of the drawing shown in *Figure 4.7*, Charles used different ICT devices, tools, and applications at different phases of his doctoral research (note the words in light blue). The initial coding list is shown in *Figure 4.12* to show how it was analysed until theoretical as well as conceptual saturation were reached.

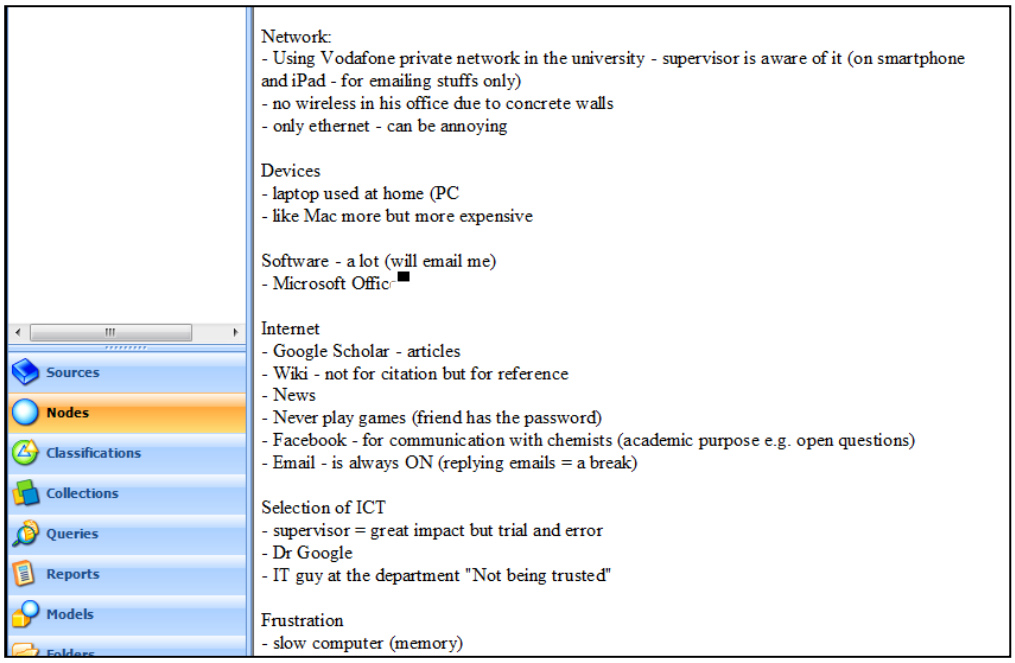


Figure 4.12. The initial coding list for Charles' drawing.

As seen in *Figure 4.12*, the initial coding list reflected the role of ICT in the doctoral research process for Charles. The list consisted of six categories: the use of network; the use of devices; the use of software; the use of internet; as well as the selection of ICT and the participant's feelings towards the use of ICT in this process (see *Figure 4.11*, Six Categories). This initial coding list was generated for each of the participants after the first participative drawing discussion session. The application of Constructivist Grounded Theory meant that that category development was achieved through coding which is the process of breaking down, separating, sorting, examining, comparing, conceptualising, and categorising data. Every segment of the data is labelled and thereby categories are formed, depicting what each segment is about. With the development of categories, the relationships between categories were established followed by further development or refinement. In this process, memos were written as a record of analysis. *Figure 4.13* shows an example of memo written for Charles in this analysis process.

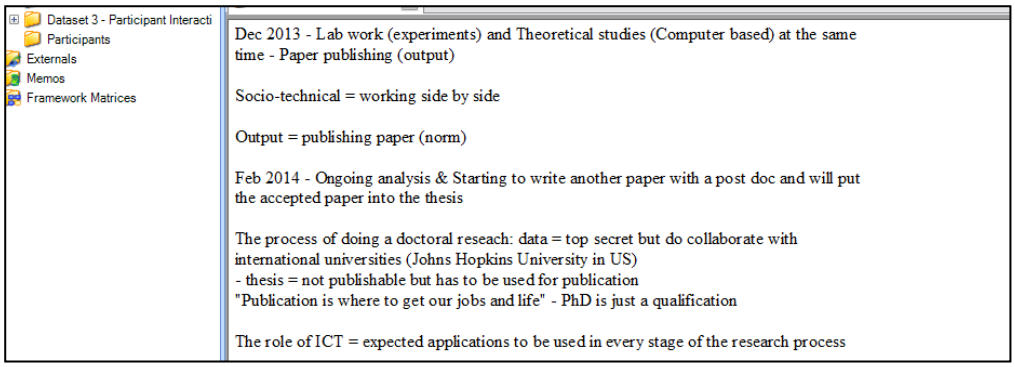


Figure 4.13. An example of memo for Charles.

Coding and writing memos gradually became more detailed and sophisticated with the involvement of both the researcher and the participants. Further analysis resulted in the generation of four features that encompassed the full variety of the role of ICT in the doctoral research process among this cohort of participants from these combined findings in participative drawing phase 1 (see *Figure 4.11*, Four Features). With the guidance provided by the socio-technical framework, overlapping features were merged and two newly structured representations were developed (see *Figure 4.11*, Two Representations), directly related to the aims of this study. An excerpt from the *NVivo* on how it supported this analysis process showing the two representations can be seen in *Figure 4.14*.

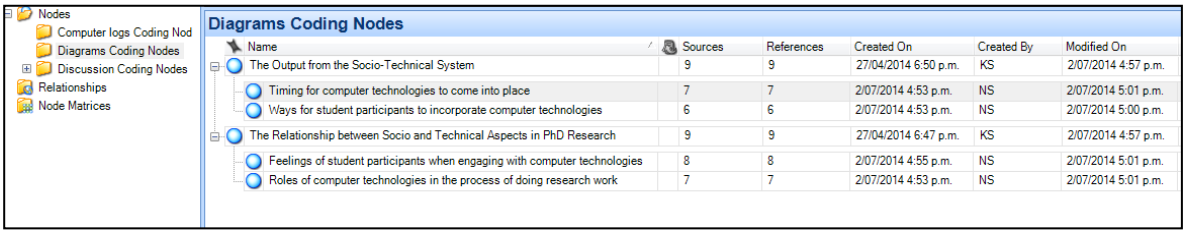


Figure 4.14. The development of the two representations.

4.5.2.2 Participative drawing phase 2.

The analysis process for this part of dataset was the same as participative drawing phase 1. However, instead of emphasising the notion of the role of ICT in the doctoral research process, this phase of analysis focused on how participants conceptualised the process of carrying out doctoral research. Using Charles' example, shown in *Figure 4.9*, he argued that Fieldwork, Analysis, and Writing phases should occur at the same time (note the writings and markings in red above these phases). The similar and the opposite frames of reference on the concept of undertaking doctoral research were noted in this coding process. This was a result of the careful and precise application of Constructivist Grounded Theory to ensure that the ideas which emerged from this study were rigorous and verified. It was a process of reality

construction that offered a comprehensive framework (including the analysis of the process), acknowledged macroscopic issues related to the phenomenon under investigation, and that acted as a precursor for further study as the research continued (Charmaz, 2006). Furthermore, because Constructivist Grounded Theory emphasises close analysis followed by the creation of an interpretive understanding and the generation of a concept abstracted from the dataset, the analysis in this phase attended to what was being heard, seen, and sensed, and pursued potential analytic ideas about the study as a consequence.

With this understanding of Constructivist Grounded Theory in mind, an initial coding list was generated, as in participative drawing phase 1, and analysed till it reached theoretical as well as conceptual saturation (Six Categories in *Figure 4.11*). Again, four features that encompassed the full variety of the conceptualisations of doctoral research processes among this cohort of participants were developed (Four Features in *Figure 4.11*). Under the guidance of the socio-technical framework, the overlapping features were merged and two newly structured representations were developed, directly related to the aims of this study (Two Representations in *Figure 4.11*).

4.5.2.3 Combining participative drawing phases 1 and 2.

With constant comparisons between and among the four representations, the use of Constructivist Grounded Theory helped to control the risk of introducing unidentified bias into the study, as the researcher's assumptions, knowledge, and ideas were forced to be treated like a dataset and applied in this comparative method. Constructivist Grounded Theory became a tool through which the methodological assumptions of this research approach were implemented and made practical. It "serve[d] as a way to learn about the worlds [being] stud[ied] and a method for developing theories to understand them". It supported a "[construction] of reality" as "[the researcher and the students] are part of the world we [were] study[ing] and the data we collect[ed]" (Charmaz, 2006, p. 10).

Therefore, a similar coding analysis approach was used for participative drawing phases 1 and 2, and that led to another focus on the socio-technical system for a PhD student in the doctoral research process. With that, overlapping representations were merged and two areas under discussion in the notion of socio-technical framework were generated. The process of the analysis for Dataset-2 is summarised in *Figure 4.15*.

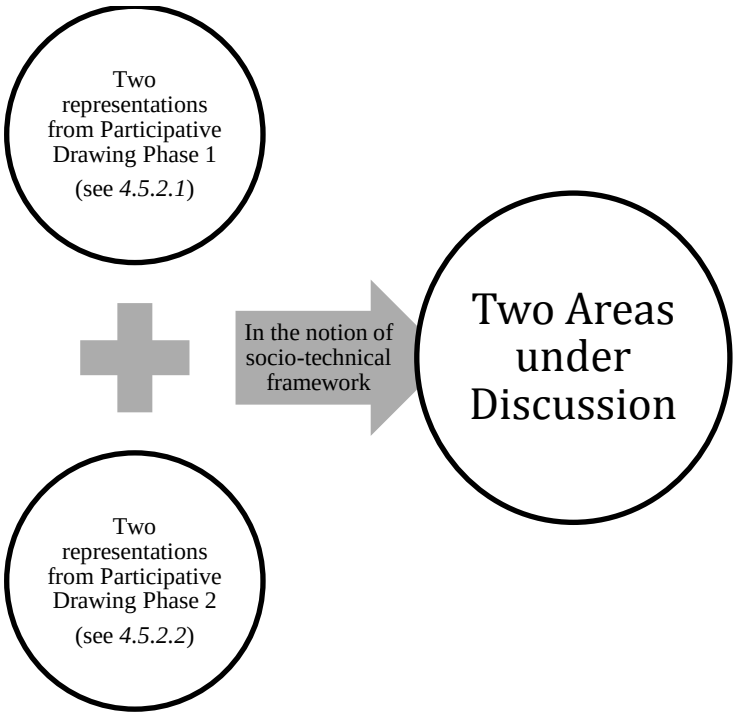


Figure 4.15. The development of the two areas under discussion.

4.5.3 Analysis of Dataset-3: Interactive data.

The strategies of coding derived from a Constructivist Grounded Theory (Charmaz, 2006) perspective were employed once again (as described in section *4.5.2*) to carry out the discussions (with photograph) data analysis. The process of the analysis for Dataset-3 is summarised in *Figure 4.16*.

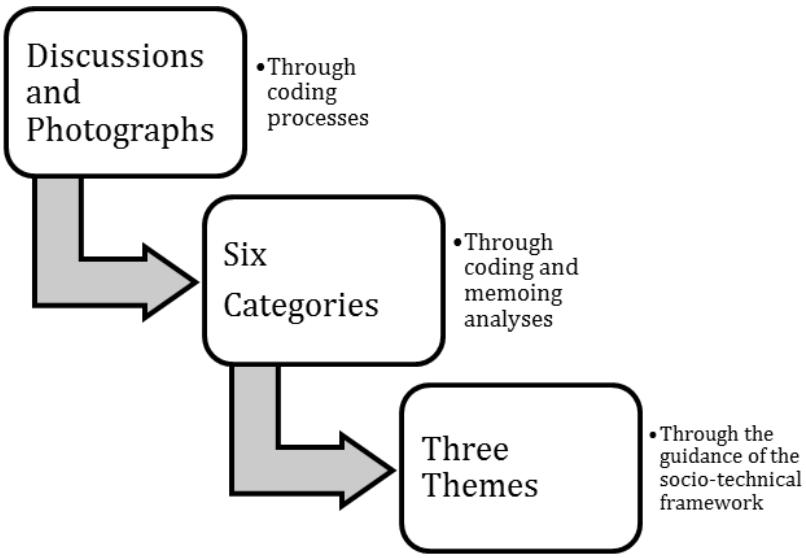


Figure 4.16. The analysis process for Dataset-3.

The top of the diagram in *Figure 4.16* shows that categories were created by coding the discussion and photograph data. In line with a Constructivist Grounded Theory approach, the

coding processes started with open coding: distributing both individual and group discussion data into discrete parts and examining the data for similarities and differences, followed by grouping them into categories. A screenshot of the discussion coding results in *NVivo* is presented in *Figure 4.17*.

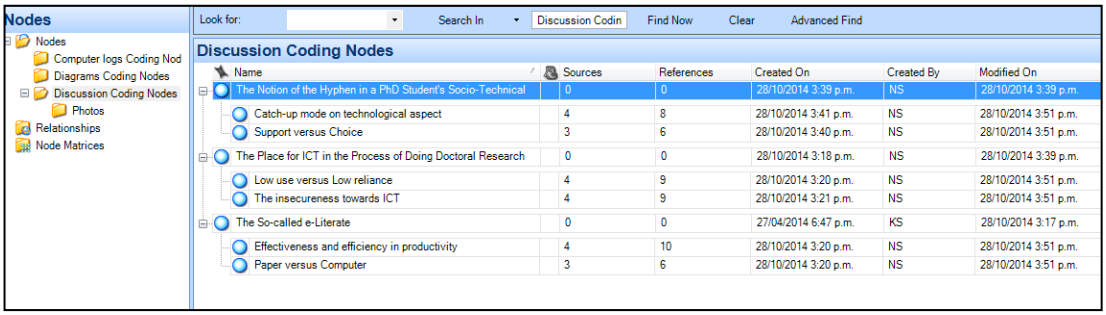


Figure 4.17. The development of categories from coding the discussion data.

Similarly, the coding process for the analysis of photographic data consisted of: examining the photographs for similarities and differences, followed by grouping them into categories. Each category of discussion and photograph data were checked with the participants' for accuracy and the inconsistencies between the researcher's assertions and the participants' interpretations were reviewed, discussed, and revised. Each category was thus associated with arguments or assertions to determine whether the interpretation arising from the data was sufficiently supported by the coded references. Through studying both discussion and photograph data, comparing the categories, and writing memos, the ideas were refined to best fit the data as a series of tentative analytic categories. With such a joint construction and co-construction of knowledge, a relational outcome was developed and an understanding of a phenomenon was generated. An example of the categorisation process is shown in the screenshot of the photograph coding in *Figure 4.18*.

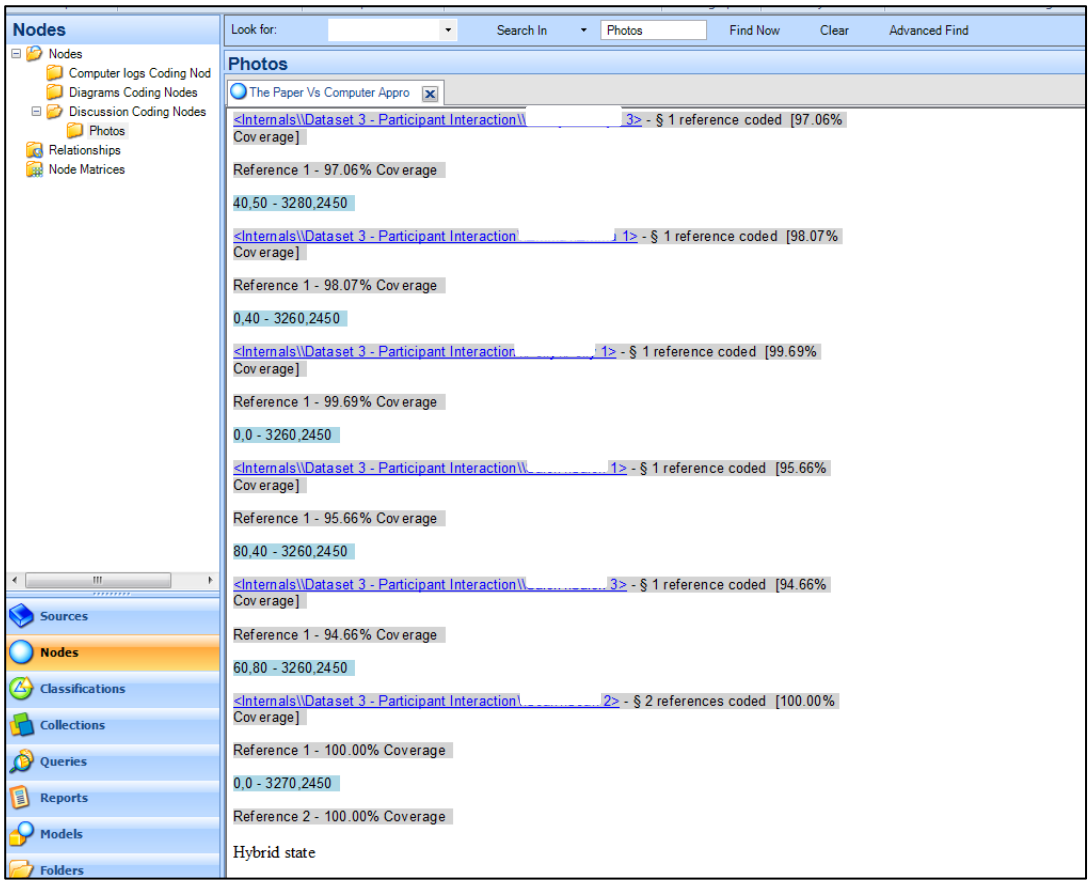


Figure 4.18. The development of codes from the photograph data.

To avoid any possible assumption that the frequency of coded categories would necessarily imply their importance to the study, every category of discussion and photograph data, no matter its frequency or its interesting points, was linked back to the research questions (see section 1.1). *NVivo*'s coding stripes played an important part in this respect, enabling the comparison of the categories with all the coded parts displayed in the node browser. This allowed for the process of labelling the categories and checking the degree of their appropriateness in relation to the research questions. During the development of categories, detailed notes and memos, consisting of summaries and propositional statements, about the developing categories were made. Clarification of the categories occurred through this iterative process of viewing and reviewing while comparing and contrasting ideas around the research questions. Six categories were developed in total, based on both discussion and photograph data. This process is represented as the Six Categories box in *Figure 4.16*.

As part of the hermeneutic dialectic process (Guba & Lincoln, 1989), recurring subjects were commented on and negotiated between participants and researcher. On completion of the classification of the categories, the categories were restructured. Assertions about participants' actions and understandings were examined repeatedly to consider how these

findings answered the research questions (see section 1.1). Finally, the categories were re-organised into three themes (Three Themes in *Figure 4.16*), which will be reported in section *5.2.3*.

4.5.4 Aggregating the datasets.

The next phase of the analysis involved noting findings of the analyses of all the datasets; and they were examined in combination as a whole aggregated set of data. This stage of analysis served to draw together interpretations from across the various datasets and focus more strongly on what they were revealing in terms of the socio-technical framework. By doing this, it made sense in terms of the interpretive, social constructivist research design as depicted in Chapter 3.

As illustrated in section 2.8 the three characteristics "Curation", "Combat" and "Coping", from Oliver's (2012) findings in his study investigating student practices around technologies and texts, were adopted for this study to categorise the observed behaviours and expressed views of the participants. This is because Oliver's work identifies the entanglements that are evident in the connections between students (social system) and their use of ICT (technical system), which was the focus of this study. Similar to Oliver's definitions, the aggregated findings showed that the participants of this study could be categorised according to the characteristics of:

- Curation – a planned process of engaging ICT in the process of undertaking doctoral research by delaying the use of ICT, but enhancing the use of non-ICT methods before using ICT.
- Combat – an opposed position to Curation that recognises the importance of ICT in the process of carrying out doctoral research as there is a feeling of discomfort in the use of ICT.
- Coping – a combination of a lack of capability with ICT as well as an ambivalent attitude towards them due to personal negative experiences with ICT.

In addition to the three characteristics, an extra characteristic, Conforming, emerged from the analysis in order to describe the beliefs and behaviours of three student participants in this study who displayed a different set of characteristics from the three mentioned above. Conforming was the characteristic generated to describe Elizabeth, Steve, and Xavier who adapted ICT use in accordance to their doctoral research. These three participants expressed an interest in making an effort to learn using ICT in order to advance their process of carrying

out doctoral research. For example, Elizabeth, who expressed her enthusiasm to learn and use ICT, did not seem to use the non-ICT methods before using ICT, as exemplified in the characteristic of Curation; she did not feel discomfort in using ICT as illustrated by the characteristic of Combat; and she did not appear to have a lack of capability with ICT nor had any personal negative experiences with ICT, as suggested by the characteristic of Coping.

A draft of the findings of the analysis of the aggregation of the data (i.e., results from each dataset analysis as well as an overall description of each participant's beliefs and behaviours) was returned to individual participants for verification and validation via an email. Three out of the nine participants replied with some minor clarification on their thoughts, their reported dialogue, or the statements on their actions. Others responded that they were satisfied with how the findings (i.e., the interpretations of their beliefs and behaviours in using ICT during the doctoral research process) had been presented. With these clarifications, the aggregated findings were able to explain the four questions that framed this study (see section 1.1).

4.6 Quality Assurance

Engaging with Guba and Lincoln's (1989) criteria for what they argue to be the adequacies of research in social science, that is, aspects of trustworthiness, authenticity, and the nature of the hermeneutic process incorporated within the research, are now illustrated. These criteria guided the planning and implementation of the study and thereby contributed to the mitigation of potential issues or limitations of involving students as researchers and the associated ethical considerations.

4.6.1 Trustworthiness.

Trustworthiness is similar to construct validity or establishing the correct operational measures for the concepts being studied (Yin, 1989). This translates into what Guba and Lincoln (1989) identify as credibility, transferability and dependability, as well as confirmability, which are elements to be considered when gauging the trustworthiness of an inquiry.

a. Credibility

> Instead of focusing on a presumed 'real' reality, 'out there', the focus [of this study had] moved to establishing the match between the constructed realities of respondents and those realities as represented by the [researcher] and attributed to various participants. (Guba & Lincoln, 1989, p. 237)

By incorporating three different types of datasets gathered over a period of six months, the study ascertained "the 'truth value' of a given inquiry, that is, the extent to which it established how things really are and really work" (Guba & Lincoln, 1989, p. 234). For example, the computer activity data (Dataset-1) captured the participants' daily computer activities; participative drawing data (Dataset-2) demonstrated the participants' thoughts on the role of ICT in their doctoral research; and the interactive data (Dataset-3) took into account participants' perspectives on the research topic. This study thus aimed to construct the reality of the role of ICT in the process of undertaking doctoral research, drawing from the socio-technical framework through processes involving over prolonged engagement and persistent observation, instead of capturing a single example of reality or truth.

b. Transferability and Dependability

The transferability of this study was established through "thick description" (Geertz, 1983, p. 27), as a way of facilitating the understanding of the study by "others who may wish to apply the study to their own situations (or situations in which they have an interest)" (Guba & Lincoln, 1989, p. 242). As this study was situated within an overarching interpretative approach, thick descriptions were unavoidable in the analysis process. This means the "complete literal description of the incident or entity [was] being investigated" (Merriam, 1998, p. 29), which helped to ensure dependability alongside "the stability of the data over time" (Guba & Lincoln, 1989, p. 242). Therefore, the participants of the study were in the loop of contact for the entire six months of data collection. Furthermore, there was a meeting with the participants every month for different purposes in accordance to the three datasets as mentioned above.

c. Confirmability

In order to enhance the confirmability of this study, the research design was structured so that "data, interpretations, and outcomes of inquiries [were] rooted in contexts and persons apart from the [researcher] and [were] not simply figments of the [researcher's] imagination" (Guba & Lincoln, 1989, p. 243). Negotiations between the researcher and the participants were conducted regularly during the data collection period and after the analysis process in order to develop assertions about the participants' understandings, as well as to reach the parity and a consensus between both parties. With this, subjectivity being attached to the interpretation of the data was minimised.

4.6.2 Authenticity.

The authenticity of a study refers to the fairness of the approach as well as the process of a study. The participants' involvement should be shown as empowering and educative (Guba & Lincoln, 1989). In this study, all the constructions and reconstructions of understandings in the data analysis process were made explicit to all the participants. These understandings were voiced during regular discussion sessions with individual participants as well as in the group discussion sessions. All the participants were informed of the researcher's ideas at all times and suggestions were invited. Each individual participant was also invited to comment on the report of the findings at the end of data analysis phase, as mentioned in section *4.5.4*. Open negotiation occurred throughout this study when any recommendation for future actions or development within the study was made.

4.6.3 The hermeneutic process.

In conjunction with trustworthiness and authenticity, "the hermeneutic process" as described in Chapter 4 acted "as its own quality control" in this study (Guba & Lincoln, 1989). In a hermeneutic dialectic process, there is continual exploration, as well as comparison and contrast, between the researcher and the participant's constructions and reconstructions of the findings throughout the period of data collection and analysis. The act of co-construction develops, refines and reiterates ideas throughout the data analysis process and involves both researcher and participants. This process results in shared understandings and expressions of ideas and avoids outcomes that are one-sided, either from the participants' or the researcher's points of view. All the data were analysed simultaneously with the data collection in order to be fed back to the participants for comments, elaborations, revisions, expansions, clarifications, and/or further explanations. In this way, the aspects of trustworthiness and authenticity worked in accordance with hermeneutic dialectic process principles.

4.6.4 Ethical Considerations.

As this study involved human participants, human ethics approval was gained through the institutional processes (see Appendix 4). This approval (University of Otago, Ethics Committee reference number 13/219) enabled data collection methods described in section 4.4 to be carried out for any full time PhD students who volunteered to participate in this study. Of particular concern was the computer activities capture. Section 4.4.1 describes in detail how these data were collected. Ethical approval was granted for the approach that was taken (see Appendix 4). The extract from the approved ethics application submitted through institutional ethics processes appears below.

Computer Activity Capture: Participants will be given free software (ManicTime) that will record the date, time, duration and type of computer programmes used as well as the date, time and duration of the websites visited over a six month period. ManicTime does not record the content of programmes or websites. An orientation session will be offered at the start of the study to inform and train participants in the purpose of using the software. They will have full control of the software, including the ability to turn it on and off and to delete the details it captures. Participants will be made aware that they may withdraw at any time and request that their data be destroyed and excluded from the study. At the completion of the project, participants will be given copies of their data (records of computer activity) and the recording software will be removed from their computers. Participants will have the option to retain software on their computers for their continuing personal use if they so wish.

The ethical use and care of the data as well as the ethical treatment of students as participants were integral to the research design, planning and implementation of the whole study. The Information Sheet and Consent Form, also approved by the University of Otago Ethics Committee, appear in Appendix 4.

4.7 Summary

This chapter outlined the methods employed in the collection and analysis of each of the datasets and the generation of findings from the data, underpinned by the research design as described in Chapter 3. It illustrated how the results emerged from these datasets and aggregated as overall findings. Chapter 5 will present the report findings from each dataset analysis, as well as the summarised results of this study.

Chapter 5: Findings

5.1 Introduction

The findings from each dataset are presented in this chapter, as are the descriptions of the four characteristics that categorise student participants' beliefs and behaviours in relation to using ICT, which emerged from the analysis of the aggregated datasets. The chapter ends with the summary list of the five areas of findings.

5.2 Findings of the Datasets

5.2.1 Findings of Dataset-1: Computer activity data.

The findings from the analysis of Dataset-1 revealed the extent to which the cohort of PhD student participants at the University of Otago claimed that they used their computers to support their daily research practice. As described in section *4.4.1*, software was used to extract computer usage data from these participants' preferred laptop and/or desktop over the period of six months (4,368 hours). These data included the 50 most used applications and the 50 most accessed document types. The usage was then categorised by application type (see section *4.5.1*) and labelled "client-side" application (e.g., *Microsoft Word* or *Window Media Player*) or "browser-based" application (e.g., *Wikipedia* or *Facebook*). These usage data were then looked at in terms of the participants' broad discipline backgrounds and PhD phases.

The computer activity data revealed that the use of client-side applications was considerably higher than browser-based applications (average = 89.40%), due to the offline activities the participants were engaging with. Table 5.1 shows the percentage of the most used applications by type.

Table 5.1 *The Most Used Applications by the Participants*

Most used applications (most to least)	Percentage Use (%)	
	Client-side applications	Browser-based applications
1	operating software-related services (42.7%)	web-browser services (52.8%)
2	*Microsoft Office* (9.5%)	email (22.2%)
3	entertainment applications (8.9%)	communication (13.9%)

The operating software-related services included the use of *Windows File Explorer*, memory stick(s), or hard drive(s), whereas Entertainment applications included *Window Media Player*, *iTunes*, or other audio and video applications. Browser-based applications included Web-browser services (average = 52.8%), email (average = 22.2%), and communication (average = 13.9%). Web-browser services comprised *Internet Explorer*, *FireFox*, and *Chrome* applications, while Communication involved *Skype*, *Weibo*, and other means of audio or video communicating channels.

At the level of application use, however, irrespective of whether they were client-side or browser-based, the computer activities data revealed the similarities as well as the differences between frequency and popularity of application use by the participants at different PhD phases as well as across different disciplines. Table 5.2 and Table 5.3 show the five most used applications, as well as the five document types that were accessed the most by the participants at different PhD phases.

Table 5.2. *The Most Used Applications by the Participants at Different PhD Phases*

Most used applications (most to least)	PhD Phases		
	Early	Mid	Final
1	office-type	office-type	entertainment-related
2	entertainment-related	entertainment-related	graphic
3	web-browser	reader	office-type
4	reader	analytical	reader
5	protection	protection	backup

Table 5.3. *The Document Types Accessed Most Often by the Participants at Different PhD Phases*

Most accessed document types (most to last)	PhD Phases		
	Early	Mid	Final
1	information/word processing	information	word processing
2	search engine	word processing	spreadsheet
3	social/university site	reader	information
4	email	spreadsheet	search engine
5	entertainment-related	search engine	email/entertainment-

Most accessed document types (most to last)	PhD Phases		
	Early	Mid	Final
			related

The discrepancy, in terms of the types, between the five most used applications and most accessed document types reflects the frequency of the participants' use of applications and their access of documents that were calculated in the unit of time (hours). For example, the participants who were in the final phases of their doctoral research used entertainment applications most frequently (Table 5.2) but they actually spent more time on word processing (Table 5.3). Thus, entertainment-related documents (e.g., Track 1.mp3 or MOV001.wmv) appeared as the most accessed document by this group of participants, but word processed documents were the document type they spent most time on.

Table 5.4 and Table 5.5 present the five most used applications as well as the five most accessed document types by the participants across four broad discipline areas.

Table 5.4. *The Most Used Applications by the Participants and their Associated Broad Discipline Areas*

Most used applications (most to least)	Broad Discipline Areas			
	Commerce	Health Sciences	Humanities	Sciences
1	entertainment-related	office-type	entertainment-related	office-type
2	office-type	reader	graphic	reader
3	reader	protection	office-type	web-browser
4	web-browser	entertainment-related	reader	graphic
5	analytical	web-browser	geographical	entertainment-related

Table 5.5. *The Document Types Accessed the Most by the Participants and their Associated Broad Discipline Areas*

Most accessed document types (most to least)	Broad Discipline Areas			
	Commerce	Health Science	Humanities	Sciences
1	information	information	word processing	information
2	reader/search engine	word processing	spreadsheet	spreadsheet/ search engine
3	university site	social	email	entertainment-related

Most accessed document types (most to least)	Broad Discipline Areas			
	Commerce	Health Science	Humanities	Sciences
4	word processing	email	information/news/ operational	university site/social
5	news	eShopping/ search engine university site	personal/search engine	presentation/reader

Despite the different rankings of the applications used the most in each discipline area, entertainment, office-type, and reader services were the most common client-side applications across all four discipline areas. As for the browser-based applications, web-browser appeared in the top five lists for all the discipline areas except Humanities. Other specific applications were found in the individual disciplines. For instance, an analytical application, *SPSS* or *Xero*, was captured as one of the top five applications for Commerce participants, and a geographical application, *GIS* or *iMap*, was noted as one of the most used applications for the Humanities participants, in this study, reflecting the particular discipline of the participants – Geography.

Similar to the most accessed document types in each phase of doctoral research process (Table 5.3), the use of information sites (*Baen ebooks* or *Bioethics*) and Search Engines (*Google* or *Yahoo*) appeared in the computer activity data related to the document types that were accessed by students from across the four discipline areas. Other common document types accessed the most were word processing, except by participants from the Sciences, and the University website, except by participants from the Humanities. The document type spreadsheet was only captured in the top five for Humanities and Sciences and the document type social was only detected in Health Sciences and Sciences.

Apart from the most used applications and the most accessed document types, the computer activities data also included the daily computer use of the participants in hours and this was then matched across the participants' PhD phases, as well as their broad discipline backgrounds as explained in section *4.5.1*. Table 5.6 shows the participants' daily computer use on average, per day, over the six months.

Table 5.6. *Participants' Daily Computer Activities (in Hours)*

Participants (pseudonyms)	Daily Computer Activities (hours/per day)

Participants (pseudonyms)	Daily Computer Activities (hours/per day)
Charles	7.70
Elizabeth	4.01
Jeremy	9.64
Mandy	12.41
Patricia	6.74
Sam	6.45
Shaun	6.16
Steve	8.54
Xavier	7.80
Mean	**8.04**

Even though the data presented an average of eight hours of daily computer activities by the participants, the range of individual participant's daily computer activities was between four and 12 hours.

Table 5.7 displays the daily starting hour of the participants' computer activities along with the participants' PhD phases. As mentioned in *4.5.1*, the starting hour of a day was divided into Early Starters (00:01 – 07:59 a.m.), Regular Starters (08:00 – 10:30 a.m.), Late Starters (10:31 – 11:59 a.m.) and Very Late Starters (12:00 noon – 12:00 midnight).

Table 5.7. *Percentages of the Participants' Average Daily Computer Activities and their Starting Times: Daily Starting Hours According to PhD Phases*

Starting Time of the Day	PhD Phases		
	Early Phase	Mid Phase	Final Phase
Early Starters (00:01 – 07:59 a.m.)	22.2%	7.1%	70.7%
Regular Starters (08:00 – 10:30 a.m.)	21.6%	51.2%	27.2%
Late Starters (10:31 – 11:59 a.m.)	43.4%	23.5%	33.1%

Very Late Starters (12:00 noon –12:00 p.m. midnight)	41.1%	22.7%	36.2%

As Table 5.7 indicates, the participants' daily starting hours demonstrated a pattern across their PhD phases in general. The participants who were in the early phase of PhD study tended to start their day late, while the participants in the latter phase of their PhD began their day early. Specifically, as shown in Table 5.7, the participants who were in their early phase of PhD (n = 3) were late (43.4% of the participants' average daily computer activities in hours who were in this PhD phase) or very late starters (41.1%). As for the participants who were in their final phase of PhD (n = 3), the majority of them were early starters (70.7%).

Table 5.8 illustrates the participants' daily starting hours against their broad discipline areas. It shows that the participants were generally regular starters in all disciplines. For instance, most of the participants were regular starters in Health Sciences (28.3% of the participants' average daily computer activities in hours for this discipline) and Commerce (59.5%). As for the participants from Humanities, the percentage of regular starters (26.7%) was only slightly lower than early starters (29.4%) and for those from Sciences, the percentage of regular starters (45.4%) was only slightly lower than late starters (46.4%).

Table 5.8. *Percentages of the Participants' Average Daily Computer Activities and their Starting Times: Daily Starting Hours According to Discipline Background*

	Disciplines			
Starting Time of the Day	Health Sciences	Humanities	Sciences	Commerce
Early Starters (00:01 – 07:59 am)	17.6%	29.4%	3.1%	0.7%
Regular Starters (08:00 – 10:30 am)	28.3%	26.7%	45.4%	59.3%
Late Starters (10:31 – 11:59 am)	20.5%	23.0%	46.4%	25.0%
Very Late Starters (12:00 noon –12:00 midnight)	33.7%	20.9%	5.1%	15.0%

In summary, the Computer activity data (Dataset-1) revealed:

1. A similar usage of the most used client-side software programmes (*Microsoft Office* and entertainment-related applications) across the participants regardless of PhD phase and broad discipline area.
2. A similar usage pattern of daily computer activity hours across the participants (average of eight hours per day for each participant), regardless of PhD phase and broad discipline area.
3. Similar starting times of the day by participants, with a majority of them being regular starters, regardless of PhD phase and broad discipline area.
4. Similar document types were accessed by the participants regardless of PhD phase, but there were different percentages, higher or lower, of different document types accessed by participants from different discipline backgrounds.

5.2.2 Findings of Dataset-2: Participative drawing data.

As explained in section *4.4.2*, the participative drawing and discussion series were conducted in a three-tier process. The finding from the analysis of the drawing and discussion are now presented with reference to relevant data from these datasets to illustrate outcomes and conclusions.

5.2.2.1 Participative drawing phase I.

The participants' drawings were discussed in the individual discussion sessions (see section *4.4.2.1*) and modified during these sessions (see Appendix 3). Out of the analysis of the participative drawing phase 1 data (see section *4.5.2.1*), two representations of the process of carrying out doctoral research by using ICT emerged:

Representation 1: The relationship between social and technical systems: At ease versus tense.

Representation 2: The output from the socio-technical system: Norms versus best practices.

As depicted in section *4.5.2.1*, these representations were constructed in the light of the socio-technical framework.

In the process of developing the two representations above, four features emerged from the first drawing and discussion sessions with participants:

Feature (a) Timing for ICT to come into place.

Feature (b) Ways for the student participants to incorporate ICT.

Feature (c) Roles of ICT in the process of undertaking doctoral research.

Feature (d) Feelings of the student participants when engaging with ICT.

Each of these features will be illustrated to demonstrate how the two representations of the process of carrying out doctoral research by using ICT emerged from the features.

Feature (a) Timing for ICT to come into place.

This feature was constructed from statements by all participants, saying they had anticipated which ICT they would need at each phase of the process in carrying out their doctoral research. Jeremy, for example, learned to use *Microsoft Excel* in the early phase of his doctoral research as he believed it would be a useful management tool for his work. Then, he learned *Geographic Information System (GIS)* when he was doing his fieldwork and data analysis, as he was told it is a necessary research software application for his research field (see *Figure 5.1*).

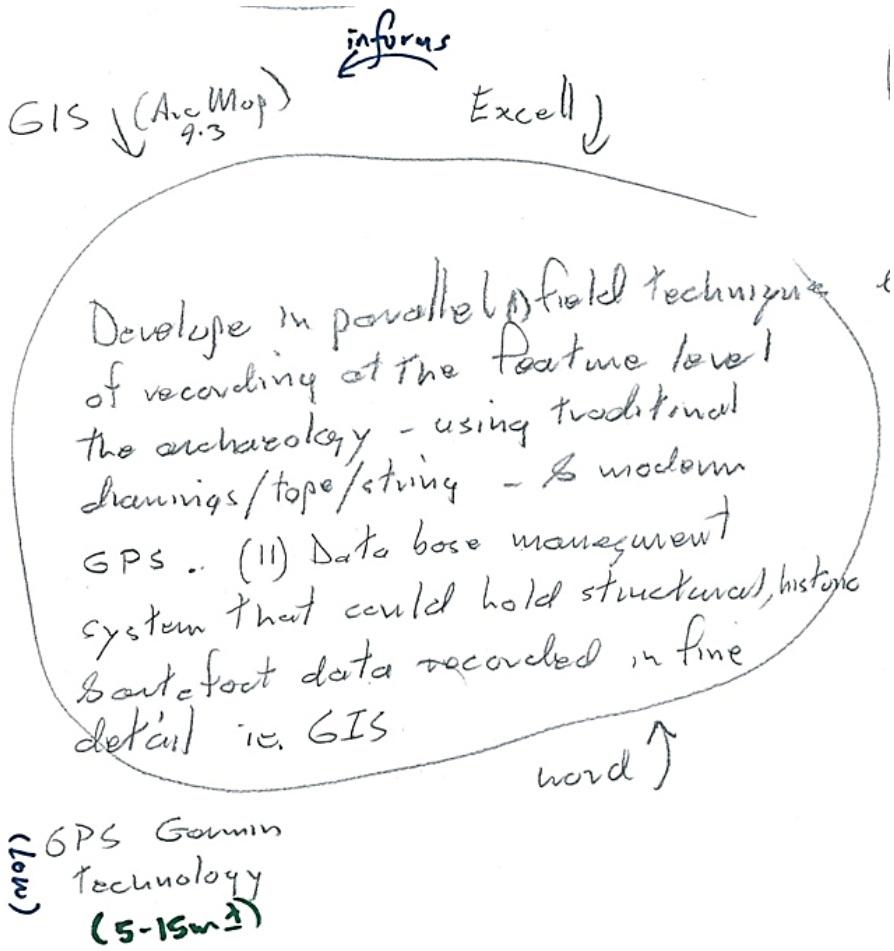


Figure 5.1. Jeremy's shift of ICT use from Microsoft Excel to GIS - an excerpt from the full drawing (see Appendix 3).

As shown in *Figure 5.1*, the use of *Microsoft Excel* informs Jeremy's use of *Geographic Information System (GIS)* for his fieldwork technique development. Similarly, Shaun realised that he needed to start using *Go* and *GIS* instead of only *Python*, *Matlab*, and *R* to establish models for his study, as well as to design tools for assessments of his models (see *Figure 5.2*).

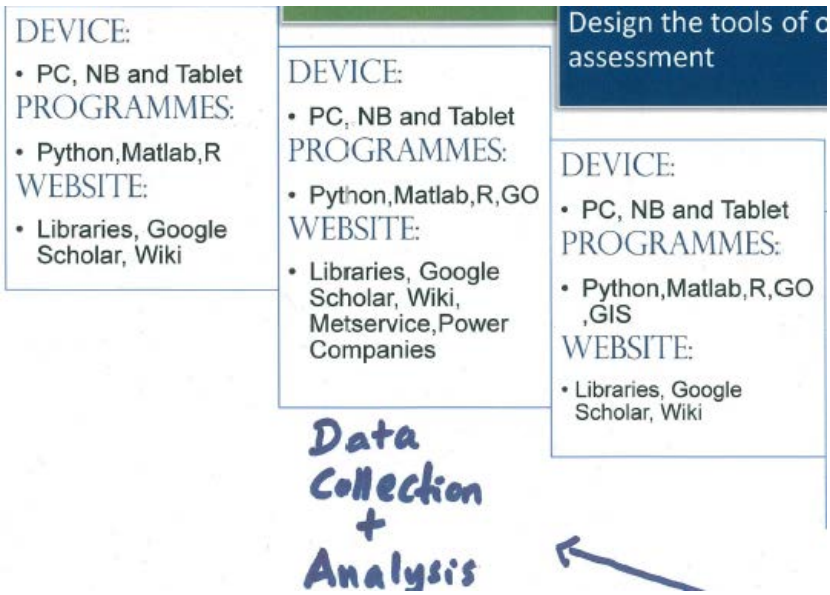


Figure 5.2. Shaun's increased selection of ICT with progress of his PhD (an excerpt from the full diagram – see Appendix 3).

Feature (b) Ways for the student participants to incorporate ICT.

This feature was constructed from the participants' reported choices of ICT that were based on their experiences in undertaking research, or through the people around them who encouraged them to start using certain software applications. This is best exemplified by Patricia who thought she could carry on managing her references by using *Microsoft Word*. However, her supervisor "intervened" in this process by encouraging her to start using *Endnote* in the third month of her doctoral research. Patricia said while discussing her drawing, "[*Endnote*] is the thing I need to get on to [to write a journal article with my supervisor by using a different referencing style but] I've never been exposed to this kind of thing before."

This was similar for Mandy. She used *Microsoft Word* only for all her research-related tasks before she started her PhD study. But, she started learning to use *Microsoft Excel* when she began her doctoral research process as she was told by her colleagues in her academic department that *Microsoft Excel* is a better way of organising her data. Her *Microsoft Excel* use began and continued throughout her doctoral study as shown in the *Figure 5.3*.

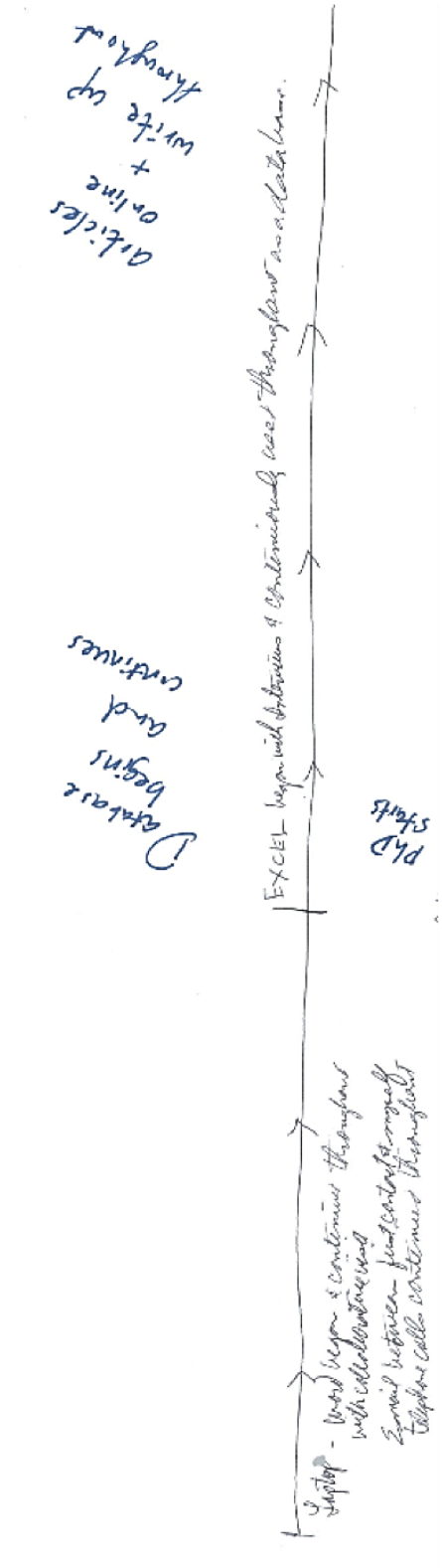


Figure 5.3. Mandy's shift of ICT use from *Microsoft Word* to *Microsoft Excel* for organising data.

Feature (c) Roles of ICT in the process of undertaking doctoral research.

All the participants agreed that ICT played an important role in the process of undertaking their doctoral research but they described ICT as "individualised tools" that assisted them to reach their "goals". All of them exhibited hybrid relationships between paper-based approaches and ICT use at their work space. For instance, although Elizabeth used various applications at different phases throughout her PhD study, she preferred to read the printed articles. She said, "Papers are more convenient". In the same way, Sam said in his first participative drawing session, "I need to use *SPSS* for sure [when I do my data analysis]. But there are times I like big calendars rather than *Google* calendar, which are more visualised." As presented in *Figure 5.4*, *SPSS* is illustrated in Sam's drawing but there was nowhere on his diagram showing the use of task management software such as *Google* calendar as mentioned in his discussion.

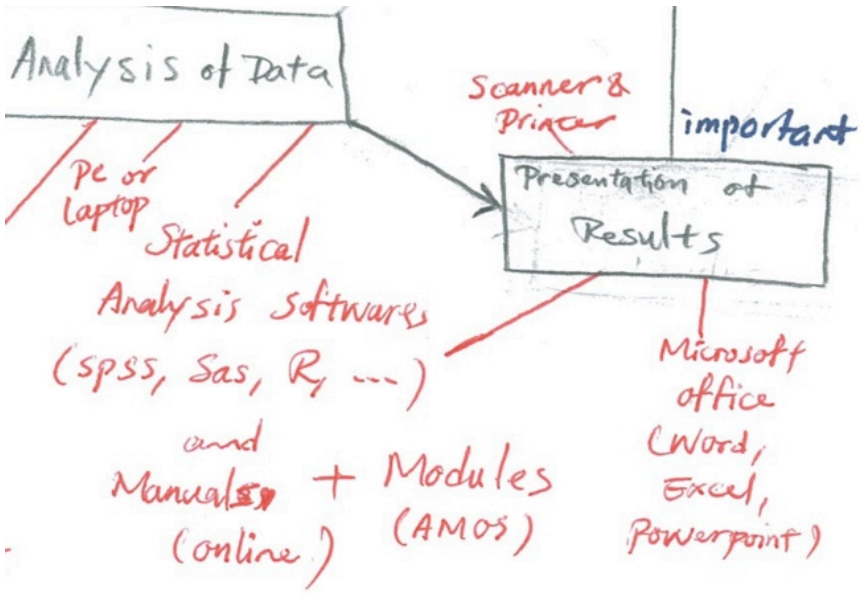


Figure 5.4. Sam's analysis phase with *SPSS* (an excerpt from the full drawing – see Appendix 3).

Feature (d) Feelings of the student participants when engaging with ICT.

With regard to this feature, all the participants demonstrated feelings of tension when they were invited to discuss their use of ICT in their daily research practice. The feelings of tension were obvious when the participants felt threatened, challenged, or even pressured to use ICT in the process of undertaking their doctoral research. This can be illustrated by Charles who chose not to learn to use the programme suggested by his supervisor to present

his chemical models as he said he could not see the differences between the suggested software programme and the software programme that he was currently using. During the first participative drawing discussion, Charles said that he chose to stay within his "comfort zone", as learning to use a new application could be a "burden" for him – "My model looks equally good as [my supervisor's] so I can't see why I need to learn a new software programme. Why should I waste my time to do so?"

Xavier preferred using *Google* to search for articles in his research area rather than using the library database recommended by his supervisor. For him, he found *Google* could accommodate his needs to get the articles he wanted better and faster than the library database at the University. Xavier said that he found learning to use library database a "hassle" despite the fact that both *Google* and the library database have similar basic article search functions. *Figure 5.5* shows an excerpt from Xavier's diagram, showing his views of the two ways of searching articles in his research area: *Google* and the University library, as mentioned.

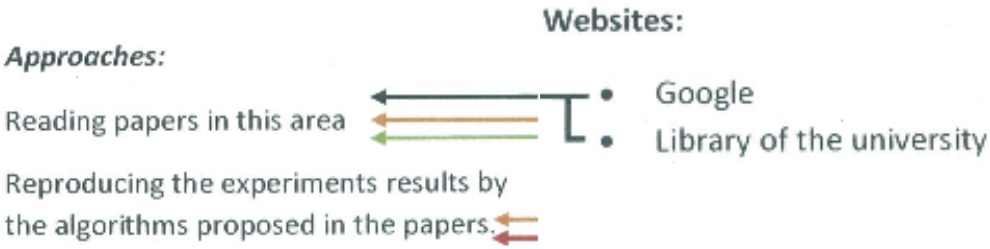


Figure 5.5. Xavier's ways of searching online articles (an excerpt from the full diagram – see Appendix 3).

5.2.2.1.1 The combination of the features for the two representations.

The four features were then combined, based on the ideas from the socio-technical framework, into the two representations as mentioned in the section *4.5.2.1*. Representation 1 (The relationship between social and technical systems): 'At ease versus Tense' incorporated feature (c) 'Roles of ICT in the process of undertaking doctoral research', and feature (d) 'Feelings of the student participants when engaging with ICT'. Representation 2 (The output from the socio-technical system): 'Norms versus Best Practices', consisted of feature (a) 'Timing for ICT to come into place' and feature (b) 'Ways for the student participants to incorporate ICT'.

Representation 1: The relationship between social and technical systems: At ease versus tense.

This representation illustrated the participants' social and technical systems in the process of their doctoral research (refer to *Figure 3.3*). A review of the drawings and the audio recordings from participative drawing phase 1 suggested that there were two types of relationship: the participants were either relaxed and comfortable in adopting ICT use in their daily research life, or they were stressed and uncomfortable in doing so. An analysis of this relationship indicated that the majority (n = 7) demonstrated a tense relationship, particularly with the technical aspect. Some examples from the data in participative drawing phase 1 to illustrate this tense relationship are:

- Jeremy emphasised how he had to learn to use new applications, such as *GIS* during his doctoral research process. He had been used to *Microsoft Excel* before he started carrying out his fieldwork for his PhD study (see *Figure 5.1*);
- Patricia said in her discussion about her drawing, "I am a routine person and so I need to start my day by checking my email, followed by browsing my *Facebook* page and Forums before I begin doing my research work". This statement suggests that if Patricia did not follow this routine by being "connected" to email and *Facebook*, she would not be able to start doing her research work;
- Sam illustrated the importance of having a printer, a photocopier and a scanner around his work space, as for him, paper-based approaches were important in his daily research work. His use of these devices demonstrated that the information Sam obtained was digital but the printer, the photocopier, and the scanner let him convert the digital to a paper format. He felt comfortable using the devices and paper documents in this way (see *Figure 5.6*); and similarly,
- Steve said in one of his participative drawing discussion sessions, "I am not sure what I am doing, but I know I need to learn about the computer stuffs [sic] in each phase of my research". This suggests a lack of confidence and uncertainty in ICT use during the doctoral research process rather than the PhD study itself.

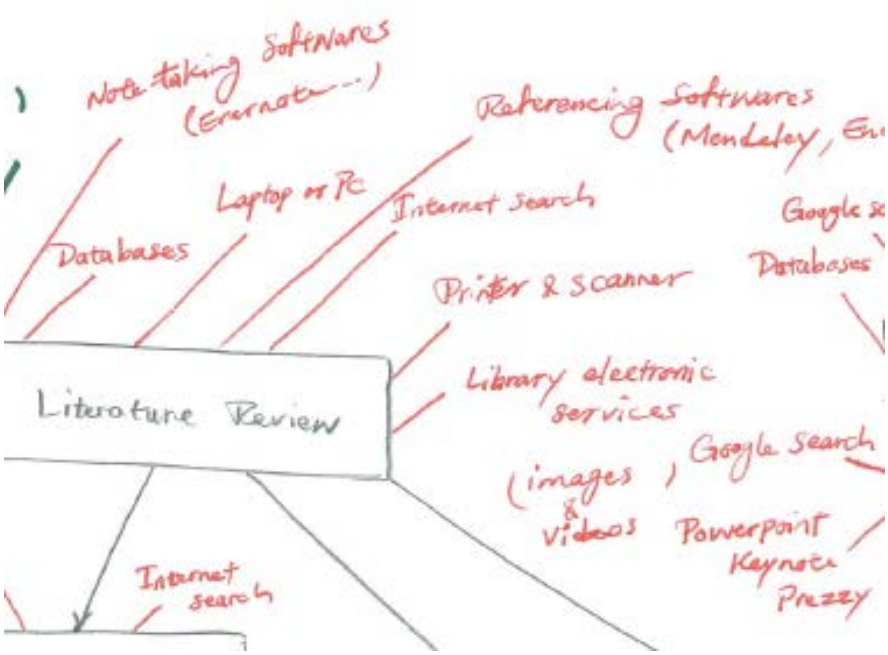


Figure 5.6. Sam's emphasis on "printer & scanner" in one of his doctoral research phase on his drawing (an excerpt from the full drawing – see Appendix 3).

In summary, Jeremy found it an "effort" to learn a new application in order to accommodate the needs of his doctoral research. Patricia had to "be connected" every day before she began her day and it could be seen as a "technological necessity" for her. Sam had to make sure he was able to connect digital resources to a printer and the printed materials were then the main working "space". Steve was constantly conscious that he had to learn a "technological skill" in order to be capable in the process of carrying out doctoral research.

As a contrast, participants such as Shaun found the socio-technical relationship in his doctoral research process was at ease. For instance, he said, "I am good at both hardware and software use … I learnt them through my industrial work [before I started my PhD]." The relationship between the social (PhD study) and technical (ICT) systems therefore appeared to be tense rather than at ease for most of the student participants in this study, especially with regard to the technical aspect.

> *Representation 2. The output from the socio-technical system: Norms versus best practices.*

This representation captures the expectations of the outcome among the participants from their interaction with the socio-technical system in the doctoral research process (refer to *Figure 3.3*). A review of the drawings and the audio recordings in the participative drawing

phase 1 suggests that the use of ICT in the production of a PhD thesis could be seen as being based on either norms (i.e., expectations and assumptions) or best practice (i.e., efficiency and effectiveness). An analysis of the ways the student participants produced a thesis from their doctoral research, in relation to their use of ICT, revealed that all participants based best practice as being unconnected to the use of ICT.

For instance, Charles, Patricia, and Xavier said they had to publish papers during the research process as it is the norm in their fields. This could be represented by what Patricia said in the discussion, "I even have to start writing papers together with my previous students based on the research that we had done." Elizabeth, Mandy, and Steve believed that they simply needed to achieve their milestones (e.g., drafting a literature review at an early phase or running analysis after data collection) at each phase in order to submit their thesis on time (a norm in their departments). Even though Elizabeth did believe in publishing throughout her process of doctoral research, she said in her second participative drawing discussion session, "I do have to focus on handing in on time - it's probably just splitting hairs." The other three participants – Jeremy, Sam, and Shaun – perceived that they used best practice in their doctoral research process but they were actually practising the norms based on their own expectations and assumptions of undertaking doctoral research. Jeremy, for example, said in his individual discussion session, "I don't know if it is possible to do [PhD study] without my working experiences as my background knowledge"; Sam stated in his session, "You need to think about the methodology and the do-ability of the project … like how it can be done"; and Shaun said in his discussion session that he would like to maintain his integrity as a researcher instead of completing the process of carrying out a doctoral research only – "My philosophy is to contribute to humankind as a researcher instead of just focussing on my PhD".

As shown in these examples, both norms – in relation to the ways of undertaking doctoral research - and the perceived best practice – in terms of their research outputs by using certain ways of undertaking doctoral research – shared by the participants were unrelated to the technical aspect. The ways they anticipated the outcome from their doctoral research did not show how they could be efficient and effective in carrying out that research through the use of ICT. The output from the joint relationship of the social and technical aspects with regard to doctoral research therefore appears to be the traditions or beliefs, constructed by a PhD student's social system, with the technical aspects fitting alongside as a supplement and

delved into or drawn upon to complete the doctoral thesis and publications, if any, when necessary.

5.2.2.2 Participative drawing phase 2.

The stimulus diagram (see *Figure 4.8*) was then used for another discussion with each participant for an individual modified version (see Appendix 3). As described in section *4.5.2.2*, two more representations of ICT use in doctoral research emerged from participative drawing phase 2, in the light of the socio-technical framework. They were:

Representation 3: The process of undertaking doctoral research: Individual versus Surroundings;

Representation 4: The use of ICT in doctoral research: Emotional versus Mechanical.

Similar to participative drawing phase 1, there were four features developed in participative drawing phase 2 before the two representations emerged:

Feature (e) The social system for a PhD student in the doctoral research process;

Feature (f) The technical system in the doctoral research process;

Feature (g) The structure of the doctoral research process; and

Feature (h) The challenges in the doctoral research process.

Each of these features will be illustrated to demonstrate how the two representations of ICT use in doctoral research emerged from the features.

Feature (e): The social system for a PhD student in the doctoral research process.

All the participants stated that their supervisor(s) played the most important role in their daily research life. Sam, for example, decided to change his supervisory team two months after starting his PhD study as he found the assigned supervisors were not "experienced" and "supportive" enough for his doctoral research. He said in the stimulus drawing discussion session, "I have three supervisors but only one is more familiar with what I am doing … I really need to know if I am in the right direction."

Similarly for Elizabeth, the notions of "networking" and being "collaborative" were significant to her doctoral research process, especially in collaborating with her PhD supervisors for publications. At the same time, she believed networking is necessary throughout the process and she was keen to have interdisciplinary collaboration in order to enhance her doctoral research experiences. But she understood this could be achieved through her supervisors. She elaborated this point when discussing part of the stimulus diagram, as shown in *Figure 5.7*.

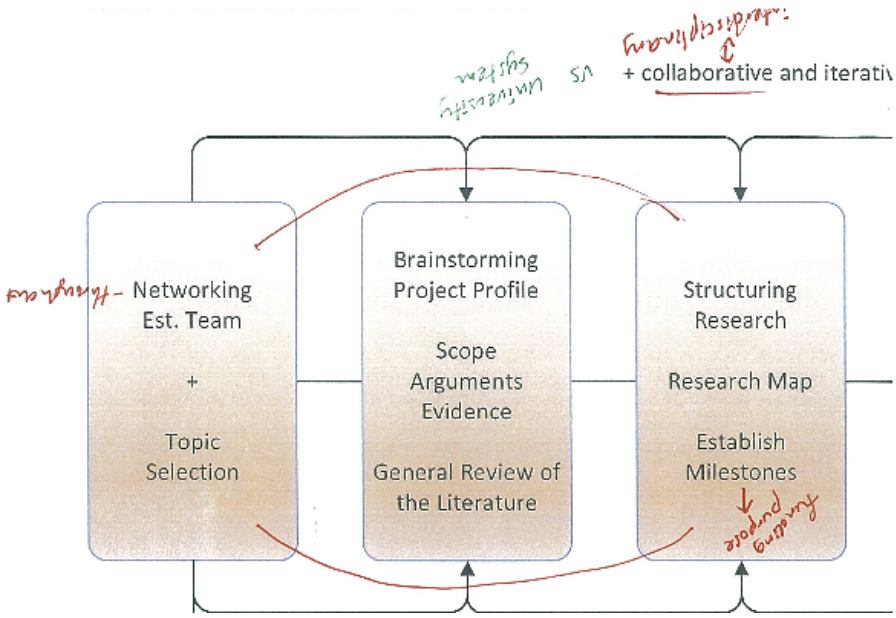


Figure 5.7. Elizabeth's comments on "networking" and being "collaborative" (an excerpt from the full diagram – see Appendix 3).

Feature (f) The technical system in the doctoral research process.

All the participants expressed their agreement that technology plays a "side-by-side" role with their research work. This is best exemplified by Steve who was in the final phase towards the submission of his thesis and reflected on the process in his individual discussion session when comparing his drawing with the stimulus diagram. He said, "Even the emails play an important part in my journey. From the communication with my supervisor to more communication with my prospective employers, it changes" (see *Figure 5.8*). Although it seems as if technology is important for Steve throughout his doctoral research process, it is emphasised as a communication tool (emails) instead of an academic tool in his daily research practice.

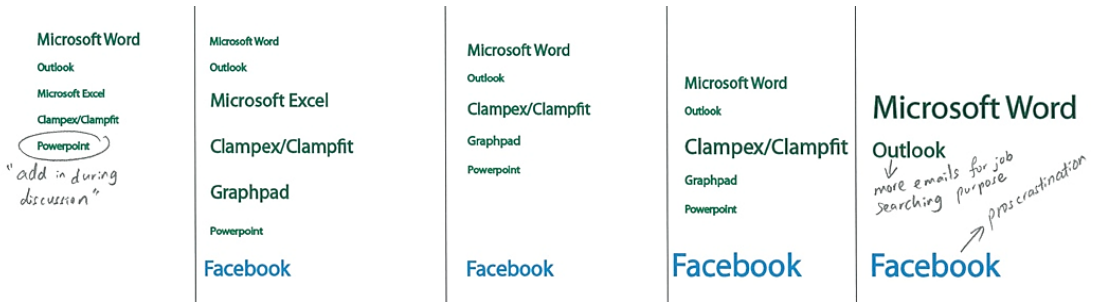


Figure 5.8. Steve's use of emails (*Outlook*) at different PhD phases (an excerpt from the full diagram – see Appendix 3).

Xavier also agreed that ICT use could enhance his abilities in the process of undertaking doctoral research. For example, he realised that because English is his second language, the translation application, *Liguoes*, supported him a lot in this aspect especially when it came to reading and writing – "ICT enhance my English abilities". Again, Xavier's emphasis on his ICT use is limited to consumption of knowledge (translation of languages) instead of production of knowledge.

Feature (g) The structure of the doctoral research process

The participants' perceptions indicated what might be described as a set of chaotic representations of the research process (see Appendix 3). There seems to be various ways of representing this process: some regarded undertaking doctoral research as a linear process while others found it non-linear; other participants thought carrying out doctoral research process is a simple and straightforward process, whereas several viewed it as a complicated process. For instance, Shaun said in his second participative drawing discussion session when looking at the stimulus diagram, "PhD research process is like cooking, it is never sequential" (see *Figure 5.9*).

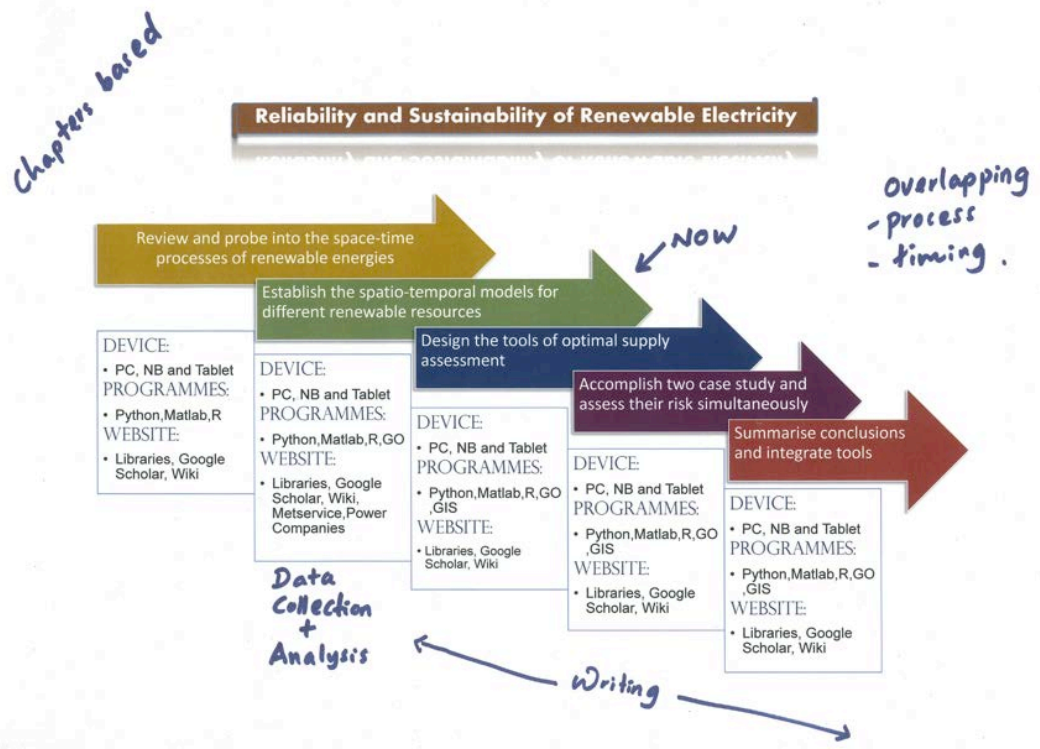


Figure 5.9. Shaun's non-sequential doctoral research.

In his second participative drawing discussion session, Shaun said he had to go forward and backward at each phase of his doctoral research as they were "overlapping". In fact, he believed doctoral research was never as straightforward as represented in the stimulus drawing. Nevertheless, Shaun regarded his doctoral research process in a non-traditional way. Evidence as sketched (*Figure 5.9*) shows a degree of "creativity" when carrying out doctoral research. For example, he said he used available data obtained online to develop his doctoral research. In fact, he considered this as a non-traditional way of data collection and data analysis. He emphasised in both his participative drawing discussion sessions how he could "review and probe in to the space-time processes of renewable energies" (the first PhD phase on the diagram in *Figure 5.9*) in order to "accomplish two case studies and access their risk simultaneously" (the fourth PhD phase on the diagram) before "summarise conclusion and integrate tools" (the final PhD phase on the diagram) as his doctoral research outcomes.

Similarly, Jeremy commented on the stimulus diagram that doctoral research could not be as systematic as represented, as most of the tasks had to be done in a parallel manner. For example, he said that the tasks of networking and structuring research could go alongside each other instead of networking it in the first place followed by structuring a research project. For Jeremy, he believed that the process of undertaking doctoral research should be non-linear. Instead of having a sequential layout as presented as the stimulus diagram, Jeremy

emphasised the linkages among the phases of doctoral research process in both of his participative drawing discussion sessions when he said, “I still believe one has to go back and forward among the different PhD phases in order to make sense of the research project instead of what this [stimulus diagram] has presented”.

Feature (h) The challenges in the doctoral research process.

All the participants indicated that they experienced feelings of “being challenged” to a certain degree while incorporating ICT into their daily research practices. This can be illustrated by Patricia who stated in her second participative drawing discussion that, “We evolve from the old fashioned styles [paper based approaches] … I am still computer illiterate”.

Similarly in Charles’s case, although publications were important for him in his discipline, he would always be cautious about where to publish his work, especially the journals with open access. As for his datasets, he would never share or publish them as he said while commenting on the stimulus drawing that his research was considered “top secret”. The role of ICT in this aspect made him feel being challenged, particularly in so far as he was not prepared to share his work until he had finished undertaking his PhD study. This idea of top secret is shown in *Figure 5.10*. Charles said, “Not for me to present my datasets, especially on the cloud ... they are the top secret of work.”

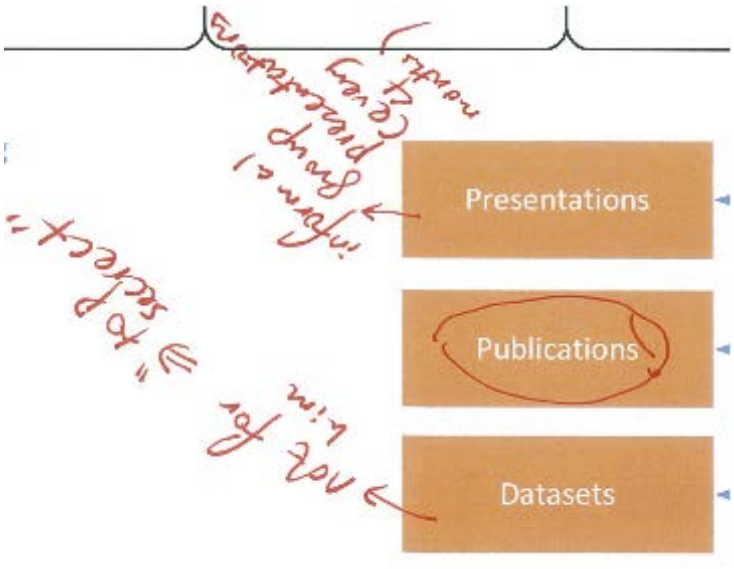


Figure 5.10. Charles’ “top secret” doctoral research (an excerpt from the full diagram – see Appendix 3).

5.2.2.2.1 The combination of the features for the two representations.

The four features were then combined, based on the ideas from the socio-technical framework, into two representations. Representation 3: 'The process of undertaking doctoral research: Individual versus Surroundings', included feature (e) 'The social system for a PhD student in the doctoral research process', and feature (f) 'The technical system in the doctoral research'. Representation 4: 'The use of ICT in doctoral research, Emotional versus Mechanical', consisted of feature (g) 'The structure of the doctoral research process', and feature (h) 'The challenges in the doctoral research process.'

Representation 3: The process of undertaking doctoral research: Individual versus surroundings.

This representation captures the participants' process of undertaking their doctoral research, whether it is a solid individual process or a process where their social system plays a significant role. Analysis of the stimulus drawing discussion data provided evidence to suggest that there are two types of processes seen by the participants in carrying out doctoral research. Eight of the nine participants perceived it as an essentially individualised process, with only one participant expecting a more collaborative environment. Elizabeth was the only participant who mentioned and saw the doctoral research process as a collaborative work between a PhD student and the supervisors. Therefore, the social system of a PhD student seems to be a lot narrower than expected, as illustrated in section *3.4.2.1*. For instance, Charles regarded his PhD research as top secret and his thesis was not able to be shared as it had to be used for publications at different phases of his PhD study. In his view, when discussing the stimulus diagram, he said, "[a] PhD is just a qualification but publication is where to get our jobs and life." Mandy, too, stated in her second participative drawing discussion session, "[a] PhD is an individual process as I already knew what is going to be expected next." At the same time, Patricia said, "I am working by myself. I don't even have a secondary supervisor" in her discussion session on the stimulus drawing. This same sentiment was expressed by Steve who said, "[there is] no networking and no team for me, only one supervisor with a topic given to me".

As mentioned previously, only Elizabeth found it necessary to network throughout the process as she saw PhD research as a piece of collaborative work with supervisors, other graduates in the academic department, and researchers outside the University. She illustrated this in her own drawing as well (*Figure 5.11*) – "I gathered a lot of ideas from talking to various people, including internationally before I started writing my PhD proposal".

Figure 5.11. Elizabeth's emphasis on networking and collaboration in undertaking doctoral research (an excerpt from the full diagram – see Appendix 3).

The stimulus diagram that included the element of collaboration appeared to be not the case for this cohort of participants, even for Elizabeth, who agreed with the necessity of collaboration, but questioned, "Does [a] PhD include collaboration and funding in reality?" at one point during the individual discussion on the stimulus diagram.

Representation 4: The use of ICT in doctoral research: Emotional versus mechanical.

This representation identified the participants' use of ICT (devices, tools, and networks) in the process of carrying out their doctoral research, whether it was an emotional process (e.g., positive and negative emotions when engaging with ICT) or a mechanical process (i.e., the use of ICT is embedded subtly in the process). The evidence gathered through the stimulus drawing discussion suggested that there were two types of engagement with ICT that the participants expressed. This was either a "love-hate" feeling towards ICT use, or a view that ICT was already embedded subtly in their doctoral research process. The majority of the participants (n = 7) had mixed feelings about using ICT; they all admitted that the use of ICT was unavoidable but they expressed explicitly that they "disliked" ICT in this process during the discussion sessions in participative drawing phases 1 and 2. For instance, Jeremy's supervisors recommended that he used *Statistical Package for the Social Sciences (SPSS)* for his data analysis, but he decided to only use *Microsoft Excel*. Jeremy felt that learning *SPSS*

was an "effort" as it was a new software programme for him. He said in the individual discussion on the stimulus drawing, "I had to determine when to stop approaching the new applications". Mandy explained how she started the doctoral research with a paper-based approach (pens and paper) to learning computer applications (*Microsoft Excel* and *Endnote*) before she had to build up the electronic documents, such as her thesis chapters using *Microsoft Word*, without any other option. She said in the second participative drawing discussion session, "I was doing everything manually and now I am building up the technological documents gradually".

Patricia, too, chose to learn and master *SPSS, Matlab, and PsychToolBox* but did not learn or use *Outlook* calendar and "stickies". Discussions with Patricia in both participative drawing phases 1 and 2 revealed that for her, there was no choice involved, as she needed *SPSS, Matlab, and PsychToolBox* for her data analysis. It seemed that for this participant at least, learning to use an application only made sense when there was a rewarding outcome. In this case, learning *SPSS, Matlab, and PsychToolBox* contributed directly to Patricia's doctoral thesis and thus it seemed to be a rewarding outcome for her. As for *Outlook Calendar*, she could easily have used a paper-based calendar to replace it and she could have substituted the electronic stickies with paper sticky notes – "No, I made my own calendar and I like writing notes on stickies". For her, the use of *Outlook Calendar* and whether she used stickies or not would not have had any impact on her process of producing her doctoral thesis.

Sam, Shaun, and Xavier conveyed their perspectives on how they "lost control" of their ICT use beyond their research context. While using ICT for their doctoral research, they also found ICT impinging on their daily lives, such as in the entertainment (*YouTube*), social network (*Facebook*), and identity (*LinkedIn*) domains. They were unsure if this was a good sign for their research life in the long run. For example, Xavier said, "You have no control on *Facebook*. … It is a youngster's doing … showing people their private life …. I am not interested to know … This is same for *Twitter*. I don't need these for my research." Shaun too stated, "I don't like social media network at all …. You have no control of them and people pass you information before you do it yourself." Both of them expressed how they had lost their control in terms of their privacy instead of gaining benefits from ICT for their doctoral research.

In addition, some participants seemed to "lose control" in determining what software applications were used for their doctoral research process. For instance, Shaun said in his

second participative drawing discussion session, after making a similar comment as in his first participative drawing discussion session:

> I am not sure what I needed to use at the start. For example, I thought I only needed to use *Python* but then later I found out that it is not enough, so I have to use *Matlab* and *R*.

This indicates that Shaun felt that he had lost control, as he found out about the ICT applications that were needed for his doctoral research, which were different from his previous assumptions. His statement indicated that he was not prepared from the beginning of his doctoral research for using the software applications he was expected to learn.

Only Charles and Elizabeth seemed to be "in control" with the software applications use for their doctoral research process. They expressed that they expected certain applications to be used in every phase of their doctoral research and they assumed there would be unexpected changes along the way. This was particularly the case for Elizabeth who found her own way to start using her bibliography application from *Endnote* and changing to *Zotero*. She said in her second participative drawing discussion session, "I needed to find my own way because my supervisors had no idea about how to use any of these referencing applications". She illustrated this again in her verification and validation email: "My supervisors didn't encourage me to use *Zotero* [or] *Endnote* - they don't have a clue about either". In a way, Elizabeth appeared to be in control of her ICT use situation.

In short, the majority of this cohort of PhD student participants revealed their emotional feelings when they engaged with ICT in the process of carrying out their doctoral research, even though they agreed that ICT use could be seen as a mechanical process in this context. The examples above show that while sharing the experiences about ICT use in the process of undertaking doctoral research, most of the participants tended to show mixed feelings towards ICT use.

As illustrated in section *4.5.2.2*, the four representations generated in both participative drawing phases 1 and 2 were merged into two areas of discussion in the light of socio-technical framework. These two areas are described in turn below.

Area A: The socio-technical system in the doctoral research process.

This area relates to the social and technical systems in the doctoral research process. It takes into account the relationship expressed (Representation 1: The relationship between social and technical systems: At ease versus Tense) and the perceived doctoral research process (Representation 3: The process of undertaking doctoral research: Individual versus Surroundings) by the student participants. For this cohort of student participants, points of tension were evident between the social and technical systems. Some participants expressed feelings of having no control over the use of ICT, as if they had no alternative but to use ICT in order to accomplish their goals for their doctoral research. As for the social aspect, the student participants perceived that they had better control. This even included the relationship with their supervisor(s). While the participants thought they could, or that they were entitled to, change their supervisory team at any phase of their research, for example, they could not change the fact that they needed to use certain applications in their daily research practice, regardless of whether they liked or disliked using the applications.

With these points of tension, the question that arises is whether the social and technical systems are co-adopted and co-adapted in the doctoral research process. In Chapter 3, the question was posed whether co-adoption and co-adaption between the social and the technical systems in the doctoral research process (see *Figure 3.3*) as the cornerstone of the socio-technical framework is aimed at the joint optimisation of these two systems to result in the best possible ways of producing a doctoral thesis. Joint optimisation emphasises the efficiency and effectiveness of ICT use in the process of completing doctoral research. With the findings that emerged from the analysis of Dataset-2, the same question, "To what degree they are co-adopted and co-adapted" was asked. The relationship between a PhD student (social system) and ICT (technical system) seems to be co-adopted and co-adapted minimally in the doctoral research process. It appears as if the systems operate as separate entities in their overall doctoral education and/or research environment.

Area B: The triangular relationship among social system, technical system, and outcome (doctoral thesis).

This area tracks the relevance of ICT as the technical system for PhD students as part of the social system in relation to the process of accomplishing their doctoral research. It takes into account the outcomes expected by the student participants (Representation 2: The output from the socio-technical system: Norms versus Best Practices) and the ways PhD students integrate

ICT in their doctoral research (Representation 4: The use of ICT in a doctoral research: Emotional versus Mechanical).

The triangular relationship among social system, technical system, and doctoral thesis shown by this cohort of participants blurred the "information flow" (see *Figure 3.2*) between the social and technical systems in relation to the goal of producing a doctoral thesis. The student participants showed a tendency to adopt knowledge (consume information) rather than to share knowledge (production of knowledge). For this cohort, the goal of producing a doctoral thesis was based on the practices of the perceived norms instead of defined best practices. The norms practised by this cohort could be considered as: consumption of information followed by the transformation of information (social creation) and ending with a compilation of a thesis (technical presentation). In other words, the information flow appeared to be a one-way flow from the technical system to the social system. The lack of production of knowledge on the digital spaces, however, shows limited impact on the production of knowledge at the end of the doctoral research process. The complexity in this triangular context thus conflates the roles of the social system as well as the technical system.

In summary, the participative drawing data (Dataset-2) analysis revealed:

1. That the social-technical systems were co-adopted and co-adapted to each other at a minimum level in the doctoral research process for this cohort of participants; and

2. The triangular relationship of the social and the technical systems with regard to the production of a doctoral thesis was viewed by the participants as complex and messy, due to the one-way information flow in this process.

5.2.3 Findings of Dataset-3: Interactive data.

As outlined in detail in sections *4.4.3* and *4.5.3*, Dataset-3 comprised three discussion sessions with each individual participant and four group discussions (i.e., Early, Mid, Final and Combined Groups as described in section *4.4.3.2*), as well as photographs of the participants demonstrating their use of ICT at their work areas. The results from these discussions, along with the photographic evidence, are summarised under three themes:

- Theme (1), the notion of the hyphen in a socio-technical system.

- Theme (2), the construct of being computer literate.

- Theme (3), the place for ICT in the doctoral research process.

As mentioned in section *4.5.3*, six categories were developed before the two themes emerged:

- Category (a), support versus choice.
- Category (b), "catch-up mode" on the technological aspect.
- Category (c), paper versus computer.
- Category (d), effectiveness and efficiency in productivity.
- Category (e), low use versus low reliance.
- Category (f), insecurity about ICT.

For Category (a), "support versus choice", all participants stated that they were the ones who chose which and how ICT devices or tools to be used in their research process, irrespective of the support or suggestions being provided to them. Xavier, for example, chose to use multi-windows on one computer monitor instead of learning to use the dual screen. *Figure 5.12* is a snapshot illustrating Xavier's use of multiple windows on one computer monitor – *TeXworks*, and two *Foxit Reader*s – on one computer monitor at one time. Charles, too, preferred to seek all his ICT-related answers on *Google*, even though there is an ICT professional working at his academic department and there is an ITS department at the University that provides ICT support to both staff members and students. He said in his first discussion session, "For me, Dr *Google* is everything." Charles preferred to try everything related to ICT by himself instead of reaching out for ICT support. After a few trials and failures, he would give up and use his own ways of handling ICT devices, tools and applications.

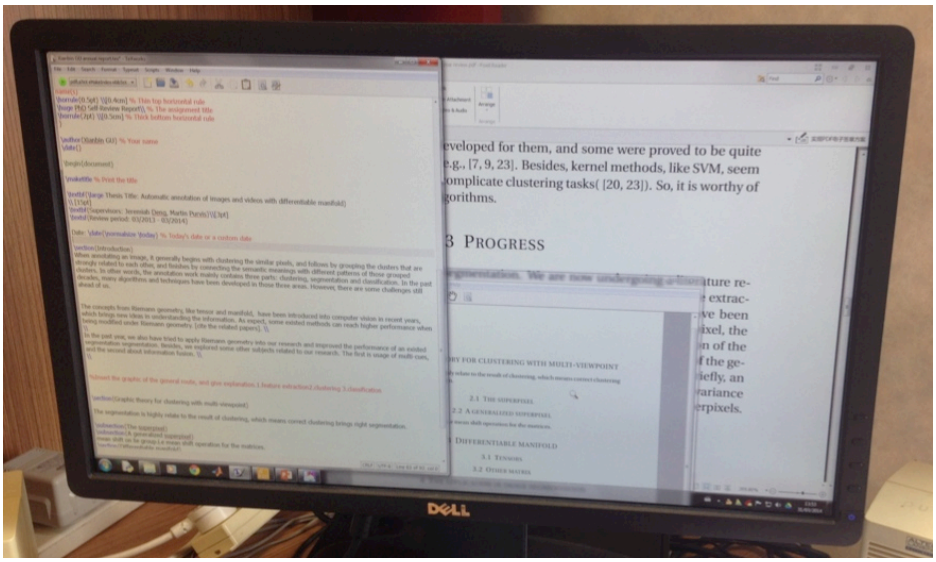


Figure 5.12. Xavier's computer screen when he was working on his proposal.

As for the Category (b), "catch-up mode on the technological aspect", there was a mismatch between the ICT abilities in research practices demonstrated by the participants and what has been documented in the existing studies (e.g., Dange, 2010) – see section *2.5.1*. The abilities shown by the participants in this study were low in comparison with what had been assumed in the existing literature despite the fact that the students were advanced academically. This is best exemplified by Mandy who said, "I can do a PhD study but I don't know how to create a folder" in her Final Group discussion session, (see section *4.5.3*). She arranged all her files on the desktop because she did not know how to create folders (see *Figure 5.13*). While creating a folder is one of the basic computer skills – a basic formatting function as illustrated in the literature (Blignaut & Els, 2010; Meerah, 2010; Wallace & Clariana, 2005) – it is interesting that Mandy emphasised what she could achieve, that is, accomplish a PhD study which is a sophisticated ability, over the fundamental computer skill of creating a folder.

Figure 5.13. Mandy showed how she arranged all her files on the desktop because she did not know how to create folders.

Similarly, Sam said in his last discussion session, "It is not good [for me] to tell my supervisors that I need more guidance on using ICT as I assume they should get the message at the supervision meetings." While Sam sounded like an experienced researcher and had a lot of research experience, ICT use was a concern for him, but due to his expressed identity as a

PhD student, he decided to wait for the supervisors to discover his needs in this respect and to provide relevant support for him.

In terms of Category (c), "paper versus computer", all the participants in this study indicated a preference for, and dependence on, paper-based approaches to support their research practice. For instance, Sam printed out his articles, highlighted the relevant sentences using highlighter pens, made notes by hand, and then typed these notes into a word document. *Figure 5.14* is a snapshot illustrating how Sam worked on paper (e.g., the highlighted pages) alongside his desktop computer with no programme open for any research-related task.

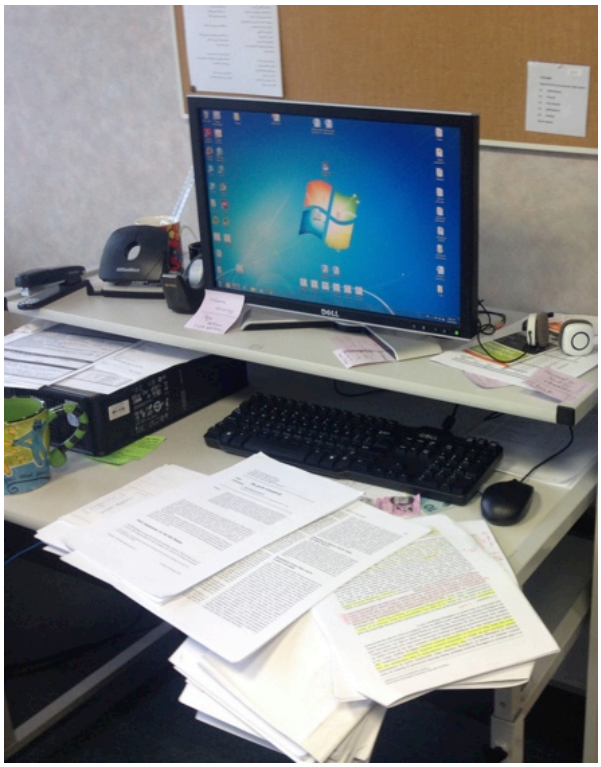


Figure 5.14. Sam's paper-based approaches versus computer use when working on his doctoral research.

Patricia, in one of her monthly discussion sessions, pointed to her book shelf and said, "I have my own library in my office and I call it my 'Paper Bank'." When the researcher "visited" Patricia's Paper Bank, it was noted that Patricia had printed out all the articles or book chapters she needed, piled them on the shelf and labelled each pile with a piece of hand written paper. In other words, Patricia relied heavily on paper-based approaches to support her daily research practices.

For Category (d), "effectiveness and efficiency in productivity", all the participants displayed a certain amount of confidence that their existing ways of incorporating ICT in their daily research practices were effective and efficient in terms of producing their doctoral thesis. This can be illustrated by Jeremy, who created a bibliography using an *Excel* spreadsheet (see *Figure 5.15*) rather than using a specific bibliography software programme. He described his *Excel* bibliography system as "better" and "more effective" than an application such as *Endnote*. He said in one of the discussion sessions, "I like *Excel* …. *Excel* allows me to sort out my [references] and generate patterns [that I need]." Mandy too, analysed all her interview transcriptions manually by hand writing all the notes. She justified this way of analysing data in one of her discussion sessions as, "I am not using an application like *NVivo* [a data analysis software application]. I do everything manually to manage the data."

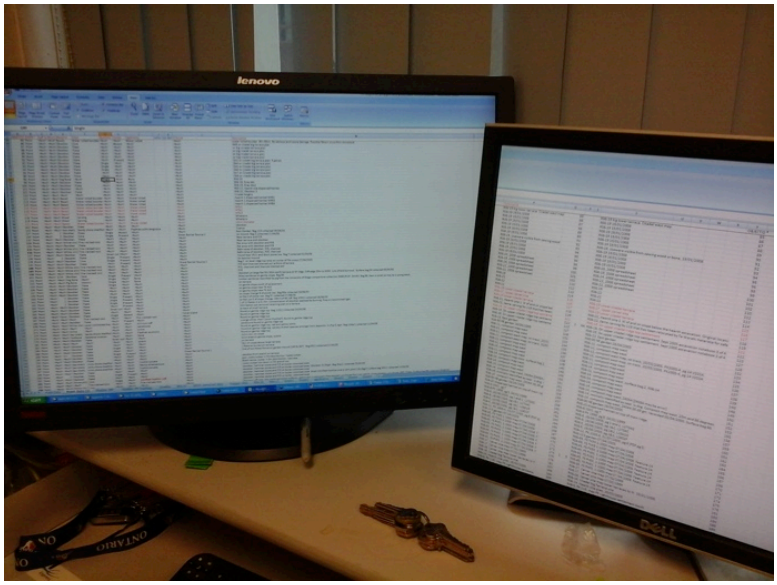


Figure 5.15. Jeremy's bibliography system on *Excel*.

With regard to Category (e), "low use versus low reliance", the degree to which the participants used their computers for their doctoral research purposes and the extent to which computer reliance had been adopted for their daily research practices was, overall, limited and low. This is best demonstrated by Charles who had dual screens but only used one; the other was turned off and was used as a "to do board" to which he added sticky notes (see *Figure 5.16*). As for Steve who was in his final PhD phase, he said in his first discussion session, "The role of ICT? It simply means more procrastination!" For Steve, ICT was a form of procrastination, taking away from the tasks to be performed at the writing phase. Steve shared how he could not control himself to use social media sites such as *Facebook* when he was supposed to be writing his thesis in the office.

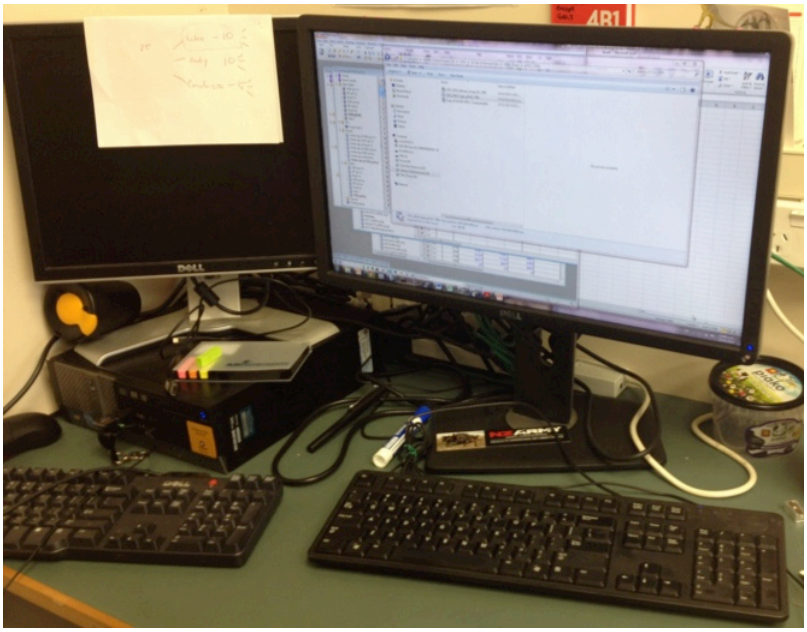


Figure 5.16. Charles's dual screen is a "to-do-board".

For Category (f), "insecurity about ICT", this cohort of PhD student participants raised concerns about the security of using ICT in their daily research practices. This is most appropriately exhibited by Elizabeth who believed it more "secure" to arrange all her referencing articles on the desktop screen for printing purposes as she said she could "see" the arrangement clearly on the screen so that she would not "lose" any article. She stated in her third discussion session, "[T]he files on my desktop are those that still need to be printed - so I don't lose track of which ones I haven't printed; once printed they are deleted from the desktop" (see *Figure 5.17*). At the same time, Shaun expressed his insecurity about the idea of using ICT. For him, ICT is "an intruder", saying in his second discussion session, "I like privacy. I don't like to be intruded [upon which ICT does]." Further, the discussion with Shaun about his feeling of insecurity about ICT began when he was introduced and pressured to use some of the social media sites online (e.g., *Facebook* and *Twitter*) where people share their life events. He thus associated any other ICT use as "intrusive" activities.

Figure 5.17. Elizabeth's articles arrangement on her desktop screen.

The six categories were then combined, based on the ideas from the socio-technical framework, into the three themes as mentioned previously. Theme (1), "the notion of the hyphen in a socio-technical system" incorporated the categories of Category (a), 'support versus choice' and Category (b), 'catch-up mode on the technological aspect'. Theme (2), "the construct of being computer literate" consisted of Category (c), 'paper versus computer' and Category (d), 'effectiveness and efficiency in productivity'. Last, Theme (3), "the place for ICT in the doctoral research process'" comprised Categories (e), 'low use versus low reliance' and Category (f), 'insecurity about ICT'.

Theme (1) The notion of socio-technical.

This theme examines the inter-relationship between the social and technical system in the doctoral research process. Similar to the findings shown in section *5.2.2*, the analysis of the audio recordings of individual discussions, Early, Mid, Final, and Combined Group discussions and photographs suggested that there seemed to be a weak connection between the social and technical systems in the doctoral research process for this cohort of PhD student participants. Instead of presenting a socio-technical relationship in the PhD students' goal-directed behaviours in producing a doctoral thesis, the socio-technical system shown is "paralysed" on one side (technical system). While the participants performed well in the dynamic social system in the process of undertaking their doctoral research, they were not acquiescent to the technical system in this process. In analysing the notion of the socio-technical system in doctoral research, all of the participants' conceptions of the use of ICT in

the process of carrying out doctoral research was different from the ones that were presented and discussed in section *2.5.2*. None of them expressed that "Using a computer makes me more organized in my graduate work"; "Using a computer makes me more motivated to do my graduate work"; or "Sharpening my computer skills in graduate school is essential in my professional work" (Shaw, 2000, p.26). The participants seemed to be unaware of what ICT could do to support their doctoral research and the efficiencies those ICT might offer them.

For example, Elizabeth regarded ICT as a tool for being connected only, rather than a tool for enhancing her doctoral research experiences. Thus she set up: a *Rich Site Summary* feed to publish frequently updated information, such as recent publications; a *Twitter* account to connect with other researchers; a *Research Gate* login to share publications; a *Linked-In* page to build a professional network, and an *Academia* platform to meet other scholars. These set-ups, however, did not play a significant role in her daily research practices as she said in her second discussion session, "These set-ups are only sitting there … but I feel good having them."

Jeremy said in his Final Group discussion, (see section *4.5.3*), "I don't believe in ICT." Mandy, also in her final phase, admitted in her Final Group discussion, (see section *4.5.3*), that she is a slow learner when it comes to ICT and therefore she gave up learning how to make the computer work for her and use of various software tools: "I am very slow in learning to use different computer tools and applications … so I chose not to do so if I could get away with it".

Patricia, who was in the early phase, was frustrated with ICT at all times and said this in her first group discussion, (see section *4.5.3*), "There are always problems with ICT, such as the computer is slow, the computer 'hanged' or the computer is getting old." Sam stated in front of the Early Group discussion, (see section *4.5.3*) that, "I am 'IN' as an ICT user but I am 'OUT' as an active computer user." When asked further about this statement, Sam explained that he would only use ICT when necessary.

Shaun, in his first discussion session, stated that he was an anti-social-media user as he found them "intimidating". Steve, in his third discussion session, expressed the thought that having *YouTube* clips playing on the laptop when writing his thesis using the desktop computer was the benefit of using ICT in the doctoral research process (see *Figure 5.18*). He stated in his verification and validation email, "[It is] a form of 'active distraction' which helped me concentrate on writing my thesis." Xavier said in his second discussion session that he was

overwhelmed when searching on *Google* as he seemed not to be able to find the information he needed.

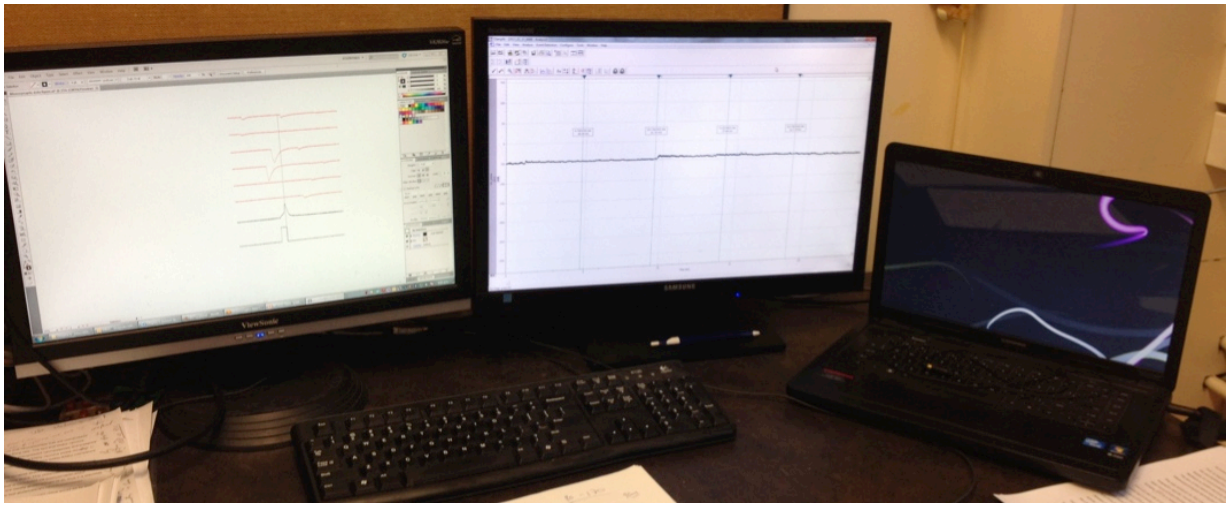
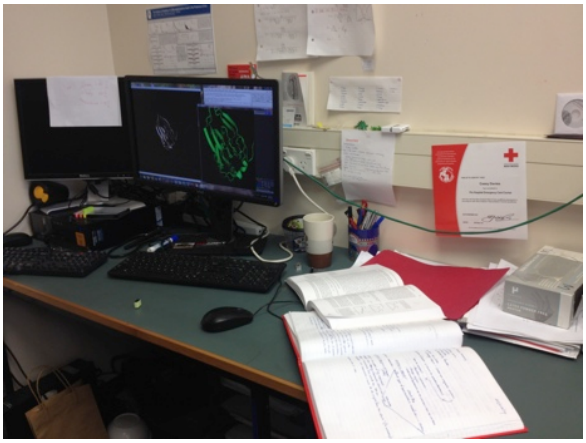


Figure 5.18. Steve's use of his ICT devices during the process of carrying out doctoral research.

These examples show that the participants had either related ICT use to social media or demonstrated an insecure feeling towards the use of ICT in the doctoral research process. Charles and Elizabeth viewed ICT as a communication tool, for example, for the use of email correspondence, while Jeremy, Mandy, Patricia, Sam, Shaun, and Xavier doubted the benefits of ICT use in this process. Therefore, their choice of academic or research-related application use was low and limited. In addition, the majority (n = 8) were sceptical ICT users. This is based on evidence provided by the participants in one of the group discussions, namely the Early Group (see section *4.5.3*), when the participants agreed that they needed to put in more effort to build a better relationship with academic or research-related applications, such as the library database, the bibliography software and the use of basic office software tools: "It cannot go like this if you want to be in [research] field", said Sam in the Early Group discussion. Patricia told the Early Group too, "I am aware of the consequences of not using [the academic or research related applications]." The connection between the social and the technical systems in relation to the doctoral research process therefore appears to be weak for the cohort of student participants in this study as the technical system seemed to be less prominent.

Theme (2) The construct of being computer literate.

This theme investigates the abilities of participants to use various software applications as part of their research practices. The theme draws attention to the relationship between being computer literate (as revealed in section *2.5.1*) and undertaking a PhD research study. An analysis of the audio-recorded data gathered during the individual and group discussions along with the photographs, implied low computer literacy of the participants even though they self-reported that they were competent ICT users (Questions 4 and 5 in the short questionnaire used as part of participant recruitment – section *4.3*). This theme, however, raises questions in relation to their knowledge of, or familiarity with, the range of available software applications, and the reasons for non-adoption of these applications to aid their doctoral research. The focus on paper-based approaches to study is illustrated in the photographic images of the participants' work spaces, as shown in *Figure 5.19*.

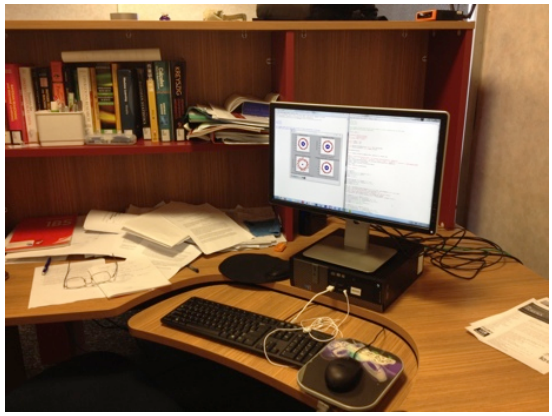


Charles

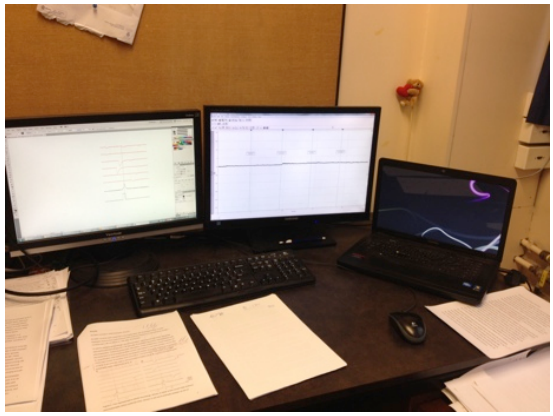
Elizabeth

Patricia

Sam



Shaun



Steve

Xavier

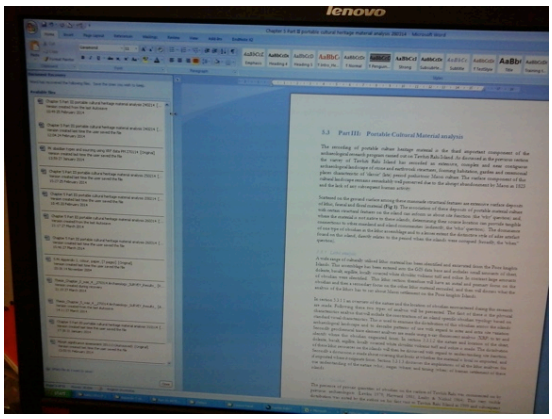
Figure 5.19. The work area setup of each of the participants.

For instance, *Figure 5.19* shows the work spaces of seven of the participants (Charles, Elizabeth, Patricia, Sam, Shaun, Steve, and Xavier). All of them had set up study areas so that they were able to use paper-based approaches when working on their research: they read from the printouts and made notes on paper. The positioning of the computer allowed them to work on paper at the same time as they worked on their computers. The emphasis on paper-based approaches is illustrated by the layout of their tables and the predominance of paper-based

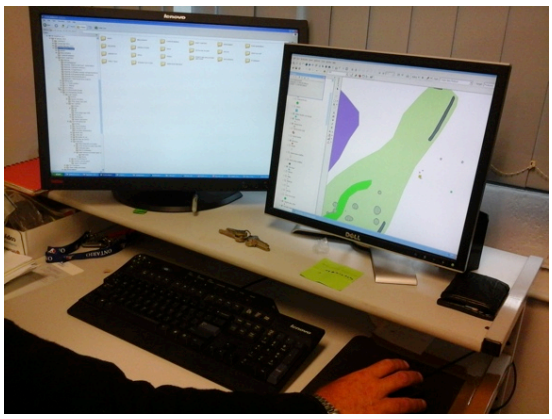
resources such as printed sheets, sticky notes, books and other stationery, including pens and highlighters.

Jeremy and Mandy, on the other hand, did not have a study space set up as the others did, but there was evidence, as illustrated in their discussion sessions, of a mixture of computer technologies and paper-based artefacts. In fact, indications of their paper-based approaches to studying were more evident than their ICT approaches. In the three individual discussions with Jeremy and Mandy, both mentioned how important paper-based approaches were to them, even though they acknowledged the importance of computer technologies in daily life generally. For example, Jeremy said in his first discussion session, "[ICT] are just management tools for me. The [paper] filing system is the more important one," while pointing to the boxes of files beside the computer table. Similarly, Mandy said in first her discussion session, "I like books … I write letters … although [computer technologies] are crucial."

It seems that for many of the participants, their ICT use reflected personal preference, task relevance and priority. Jeremy's case was perhaps the best example of this as he preferred to keep and work from all the auto-recovered files (i.e., the missing files in the *Windows Document Recovery* task pane) instead of learning to create and manage a file system on his computer or to have a backup file system to keep his documents (see the photograph on the left in *Figure 5.20*). Despite this, Jeremy appeared to be a competent *GIS* user, as evidenced during the observation and individual discussion sessions (see the photograph on the right in *Figure 5.20*). But using *GIS* took a higher priority than learning to manage files on the computer, for Jeremy. Further, using the auto-recovered files for retrieving documents made more sense to him than creating a file system. In this case, only the learning of *GIS* seemed to be considered directly relevant to his doctoral thesis, whereas managing a file system on the computer was not. His personal preference for managing his documents appeared to have no impact on his process of producing a doctoral thesis.



Jeremy's auto-recovered documents



Jeremy's *GIS* use

Figure 5.20. Jeremy's auto-recovered documents versus GIS use.

As shown in these examples, both the paper-based approach as well as the individual perceived efficient and effective behaviours indicated limited computer literacy. Evidence gathered during one of the group discussions suggested that, for most of these PhD students, their levels of computer literacy or knowledge and acceptance of some typical academic-specific applications, such as bibliographic and task management software, was low. Rather, they explained that they were confident that their existing computer literacy was sufficient to accommodate and achieve what they aimed for in their research. For instance, Charles said in his second discussion session, "We just have to practise [using the computer devices], trial and error … and I got [what I want]". Steve too said in his Final Group discussion session, "We rely too much on the computer … we should manipulate it instead [to achieve what we want]."

In short, this theme shows that from the PhD students' perspectives, they might not need to be computer literate to carry out doctoral research. This is in contrast with the existing literature (see section *2.5.1*).

Theme (3) The place for ICT in the doctoral research processes.

This theme examines how ICT is situated in PhD students' day-to-day research practices. The analysis of the audio recordings of individual and group discussion sessions as well as photographs revealed that there was not only low use and reliance on academic or research software applications by this cohort of participants, but a demonstration of resistance towards ICT; that is, they said that they were not confident of the benefits of using ICT in their daily research practice. For example, Mandy regarded academic or research-related applications as complex platforms that would require commitment as well as time to master. She said in her

third discussion session, “I don’t do anything [using *Endnote*] to change anything [in a word processed document] because I don’t want to screw things up”, even though she had been introduced to bibliography programmes at the start of this study. This view of *Endnote* – as an application that could “screw things up” – was set against her perspective that applications such as *Gmail* and *Windows Media Player* were intuitive and simple to use. For instance, Mandy said, “My *Endnote* always crashes and that makes me lose my references” while showing her references on *Microsoft Word*, which gave her more confidence in organising her references (see *Figure 5.21*). Another example is of Sam, who said in his second discussion session, “Why do I need to use all these [*NVivo*, *Endnote*, *SPSS*, *Outlook Calendar*, *PDF Editor*]?” when being introduced to a few relevant software applications, which he believed were not able to enhance his doctoral research process. He said, “I only use what I think is more reliable” and “I am not in a relationship with [these] software applications”.

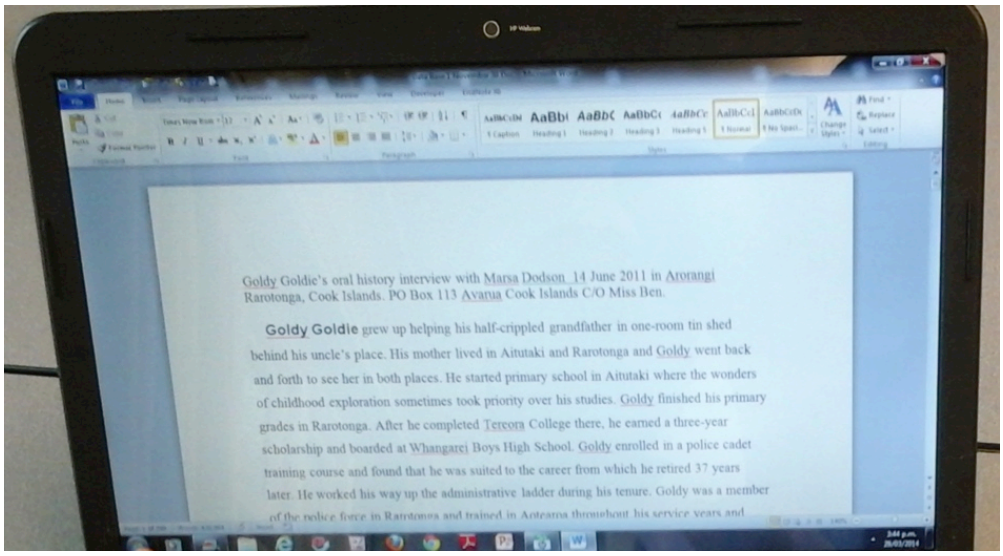


Figure 5.21. One of Mandy’s references with its summary on Word.

Despite encouragement from supervisors and experience of specific training, the translation of the PhD students’ use of ICT into practices that were embedded into everyday academic behaviour did not happen without effort. Steve best illustrated this in his verification and validation email:

> I basically extend my IT skills in a use-dependent manner. I learn new things when I need to learn them. [But] we are sometimes restricted by the ‘inbuilt’ functions of the computer for things like data analysis. And that it would be more useful for students to learn to program the computer to do exactly what we need it for, rather than use it with what it already has.

In a way, Steve could see risks: the effort it takes to learn a software application for his doctoral research against the need to minimise the risks of making errors while using the software when he was not fully conversant with it. Conceivably, for Steve, embedded ICT use in daily practice could happen when the environment in which the applications were used is at low-risk.

In summary, the findings from the analysis of Interactive Data (Dataset-3) revealed that:

1. There seemed to be a weak connection between social aspects and technical aspects in the doctoral research process for this cohort of participants.
2. The level of computer literacy of this cohort of participants seemed to be low.
3. The place of ICT in the process of undertaking doctoral research for this cohort of participants is vulnerable.

5.3 The Characteristics of Individual Participants

As mentioned in section *4.5.4*, the aggregated findings from all the datasets were reanalysed as a single dataset and produced a set of characteristics that highlighted the nature of the participants' engagement with ICT. The behaviours and expressed beliefs of the individual student participant are based on Gourlay and Oliver (2012) characterisations of Curation, Combat and Coping (see in section 2.7), with the addition of a fourth characterisation, Conforming which is explained in section *4.5.4* as emerging from the analysis. The descriptions of these characteristics as they relate to the students who participated in the study are described below.

Patricia and Shaun might be characterised as reflecting an approach of Curation; engaging in a planned process of using ICT in undertaking doctoral research, based on their understanding of the needs to do so in this process. This approach was illustrated by Patricia who intentionally postponed learning, or even using, a software application during her doctoral research process. Patricia admitted in her Early Group discussion, "I am afraid of learning new things, especially technology". Shaun, too, tried hard to maximise the use of "non-ICT" methods in his daily research practices, believing too much time was spent on technology nowadays and there should be a return to the paper-based approaches of the past. Both Patricia and Shaun expressed a strong indication for the methodical strategy of incorporating non-digital approaches alongside their ICT engagement in the process of their doctoral

research. For them, the best possible way of ICT use in the doctoral research process was "a process of collection, collation and transformation of texts to form a personalised digital repository, using techniques such as extensive digitisation of print texts and the overlaying of digital notes", which aligned with Gourlay and Oliver's (2012, p. 2) participants of this characteristic in his study. This way of ICT use might be efficient for both Patricia and Shaun in their process of carrying out doctoral research, but their effectiveness was compromised as they decided to continue working with their own well-practiced ways.

In contrast, Charles and Sam's approach might be characterised as Combat: the direct opposite to Curation. They recognised the importance of ICT in the process of carrying out doctoral research but felt uncomfortable using ICT. Charles doubted that learning to use a suggested software application would enhance his doctoral research as his existing ways of doing things were achieving the outcomes he had planned. For example, his best possible ways of using ICT were by not changing his practices, including not learning how to use a new software application, unless it was vital for him to do so. Sam did not understand the role of ICT in enhancing his doctoral research process, as he was not confident that ICT had the functions and reliability he needed. Both Sam and Charles indicated that they felt uncomfortable in the use of ICT for their study. Sam stated firmly in his Early Group discussion, "I am not reaching out to learn new technologies." For Charles and Sam, the best possible way of using ICT in the doctoral research process was by continuing to use them as they had always used them, as they did not believe ICT use could enhance their research experience in any way. Although they perceived that they were efficient in the ways they undertook their doctoral research, the effectiveness of their doctoral research experiences when they decided to continue working with their own ways as illustrated was low and limited.

A third and different characteristic, shown by Jeremy and Mandy, provided an account, which can be best described as Coping: a combination of a lack of capability with ICT as well as an ambivalent attitude towards it due to personal negative experiences with ICT. Because of the many struggles that Jeremy had experienced in learning how to use ICT, he did not trust that they could help him with his doctoral research. Jeremy was very confident that he knew what worked well for him. For instance, instead of learning to use a software application suggested by his supervisors, he believed it was better to use another software application that he considered to be more suitable and involved less work or learning. Mandy, too, doubted the benefits of engaging ICT in her doctoral research because of negative experiences. Mandy

said in her Final Group discussion session, "[It is more important to know] how can technology help me instead of what I should do with this piece of technology" when being introduced to an academic or research-related software application. For both of these participants, their best possible way of using ICT involved being comfortable and confident in what they are using. Their effectiveness in the ways of carrying out their doctoral research might have been risked at the expense of the individual participant's views of efficiency.

Lastly, Elizabeth, Steve and Xavier's characteristics could be described as Conforming: a process of adapting ICT use in accordance with their phases of carrying out doctoral research. Elizabeth was keen to make an effort to pick up new technological skills from time to time in order to improve her doctoral research. She started to adapt gradually from using paper to using ICT, such as adopting *Google* calendar instead of having two identical calendars, in both paper and electronic forms. Steve was an active ICT user who engaged with ICT as much as possible in each phase of his doctoral research. He explained this use in his verification and validation email, "I'm not even using paper/lab books anymore. I take all my notes for seminars/experimental notes on a laptop now." Steve stressed in all his discussion sessions that he used different ICT devices, tools and networks at different phases in his doctoral research. Xavier was in favour of picking up new technological skills gradually to increase his efficiency in carrying out doctoral research, but Xavier implied that he had no choice but to have extreme engagement with ICT due to his research field in Computer Science. The three of them expressed a strong indication of aligning their ICT use with the progress of their doctoral research. Their best possible ways of using ICT in this process complied with their perceived ICT needs in respect to their doctoral research. For example, the worth of ICT use changed in line with their perceptions of need in the process of carrying out doctoral research. Such level of efficiency in using ICT might have affected the participants' effectiveness in the ways of carrying out their doctoral research.

In short, these four characteristics reflect the relationships between the PhD students' observable behaviours and expressed beliefs in relation to their ICT use in the doctoral research process, in terms of their notions of best possible ways of using ICT. As shown in the examples, the participants in this study constructed the concepts of being efficient and effective by using ICT within their individual contexts. The pursuit of efficiency compromised effectiveness when the participants decided to continue working in their own ways (Charles, Patricia, Sam, and Shaun). At the same time, effectiveness might have been pursued at the expense of the individual participant's efficiency (Elizabeth, Jeremy, Mandy,

Steve, and Xavier). Therefore, the notion of the best possible ways in regard to the role of ICT in doctoral research is reliant on an appreciation of the mediating processes in an individual PhD student's context that hold the relationships of the social and technical systems together. In the case of this cohort of participants, this notion applies to those who act according to their construct of "needs" and "outcomes". Therefore, what the participants constructed as being efficient and effective by using ICT in their individual doctoral research led to their construct of the 'best possible ways' in regard to the use of ICT.

5.4 Conclusion of Findings

This chapter presented the findings from each dataset, as well as the four characteristics, which categorised the participants' behaviours and beliefs in detail and provided a comprehensive analysis of the three notions situated within this categorisation. In summary, the key findings were:

1. *ICT use and PhD phases:* The ways PhD students used ICT in the process of undertaking doctoral research were similar, regardless of their PhD phase.

2. *ICT use and discipline backgrounds:* PhD students used ICT in the doctoral research process in similar ways, regardless of their broad discipline areas. The only difference was the frequency of the document types they accessed.

3. *Social system and technical system:* The socio-technical systems in the doctoral research process in regard to the PhD students' goal-directed behaviours of producing a doctoral thesis in the best possible ways are co-adopted and co-adapted to each other at a low level.

4. *Computer literacy and academic qualification:* The computer activities of the PhD students in their day-to-day research practices showed a misalignment between their level of computer literacy and their advanced level of academic achievement.

5. *Individual student and student cohort:* Individual PhD students presented differences in their ways of using ICT during their doctoral research process but their concept of ICT use was not different as a cohort. The characteristics of Curation, Combat, Coping, and Conforming situate within the context of PhD students' ICT use in their doctoral research process. These characteristics reflect their notion of best possible ways in using ICT to be efficient and effective while accomplishing their PhD study.

These findings serve to highlight the variety of notions of ICT use expressed by the participants in the study in terms of the "best possible ways" to facilitate efficiency and effectiveness in the ways of carrying doctoral research. The next chapter discusses the findings in the light of the socio-technical framework, which underpinned in this study. The chapter also reviews the notion of socio-technical in the context of this study as well as higher education more broadly.

Chapter 6: Discussion

6.1 Introduction

This chapter presents an appraisal in the context of the research questions of this study as well as the themes that emerged from the literature and the findings generated from this study, in light of the socio-technical framework which underpinned in this study. As detailed in section 1.1, the aim of this study was to investigate the beliefs and practices related to ICT and research processes held by students as they undertake their PhD study. The following questions were framed around this aim:

1. To what extent do PhD students at different phases of their study and from different disciplines use ICT to support their research process?
2. How do the assumptions and expectations of ICT held by PhD students influence their ICT practice; and how do PhD students' ICT practices inform their perspectives on ICT use?
3. What is the relationship between the ICT assumptions, expectations, and actual practice of PhD students and related claims concerning the role of ICT documented in the research literature?
4. How is the nature of ICT use among PhD students established from this study beneficial for different communities (the institution, the disciplines, the lecturers, the supervisors, and the students)?

The discussion is structured around four sets of ideas: preference of approaches to using ICT; computer literacy; ICT use and the social system; and ICT use and the technical system. This discussion is followed by a review of the socio-technical schema in the context of this study and more broadly in the context of higher education.

6.2 The Discussion on the Four Sets of Major Ideas

6.2.1 Preference of approaches to using ICT.

The PhD students who participated in this study generally preferred to use traditional paper-based approaches when studying in a digital environment (see *Figure 5.19*) for drafting, planning, and information management, even though they had their ICT devices on their desks at all times. This is not to imply that paper-based approaches are inappropriate, but that ICT devices appeared to be seen as tools to augment the primary processes associated with paper-based methods. Paper-based approaches were particularly obvious in the common

practice of these students who regularly printed digital resources. The consensus held by these students was that this method of converting to paper made for a more efficient and effective way of handling, using and managing materials.

In addition, the findings in this study also showed that some of the participants employed a "hybrid state" of ICT device use at their study desk. They demonstrated using multiple methods, including some traditional and some personalised ICT use in their daily research practices (e.g., see *Figure 5.14* and *Figure 5.16*). For instance, Sam searched for literature on the desktop, had his laptop turned on at one side for email, and was connected through *Messenger* via his smart phone (see *Figure 5.14*). This may suggest a greater focus of ICT use on "being connected" through using email and messenger rather than on "producing work", such as drafting and writing.

The students appeared to deploy ICT for different tasks as their preferences dictated. While the preferences seem to be reasonable, it is worth contemplating whether these preferences contribute to the development of ICT skills that reflects the intended graduate profiles of PhD students (Wellington, 2012) as presented in section *2.5.4*. At the same time, it was interesting to discover that the participants in this study associated Internet searching with learning. For example, Elizabeth searched for all the articles she needed for her PhD study on the Internet (e.g., through the library database and *Google Scholar*) and printed them out to be filed manually at her work area. She then worked on these print-outs using a pen and a highlighter before typing them into a word-processor application (*Microsoft Word*). This suggests that Elizabeth tended to use ICT as information consumption tools rather than for production (knowledge creation) and distribution/networking purposes (e.g., knowledge sharing). While this practice may sound logical, it raises the question about whether PhD students are treating ICT simply as devices for accessing web-based information (Dahlstrom et al., 2011). If so, this might indicate that production capabilities offered by ICT have been subordinated to their consumption capabilities by these students.

In short, the above-described ICT practices could be examples of a student's personal approach to carrying out research practice, but from a higher education perspective, they could be considered as concern. Using Pinch and Bijker's (2012) high-wheel "ordinary bicycle" example (see section *2.3.1)*, ICT devices, tools and applications have been designed and developed by someone who could envision ways of solving problems, to make academic work quicker, easier, more efficient, and more effective. By using ICT, students may be able

to receive all those benefits the device, tool, or application affords. Simultaneously, the ICT device, tool or application will also have an effect on student users; such as influencing and determining their thinking and behaviours in relation to undertaking and completing tasks in ways that other technologies, such as pen and paper, were unable to afford. However, this seems not to be the case for the cohort of PhD participants in this study and thus could be a cause for concern about PhD students missing opportunities to optimise a more sophisticated potential of ICT use for their study work.

6.2.2 Computer literacy.

The findings from the analysis of Dataset-1 showed that there is a similar usage of client-side software programmes and document types by the participants regardless of their PhD phase (see Table 5.2 and Table 5.3) and their discipline background (see Table 5.4). The different document types the participants from different discipline backgrounds accessed the most (see Table 5.5) as presented in the data may not be surprising, given the different nature of research in different disciplines. The similar use of software programmes would suggest that the PhD students did not use many specific software programmes that reflected their PhD phase or discipline background. At the same time, participants in this study presented a remarkably similar usage pattern during their daily computer activity hours. The data showed that these PhD students appeared to view doctoral research as a full time job. They were generally on their computers by 9 a.m. and continued throughout the day until finishing around 5 p.m. (see Table 5.6). However, the actual applications used were limited to word processing and Internet browsers, regardless of PhD phase and discipline background (see Table 5.1 – Table 5.5). It was expected that, given their self-reported high levels of confidence with ICT and their academically advanced level, there would be a pattern of computer activities that aligned with their PhD phase or discipline background. The findings, however, did not support this assumption. This insight is similar to the findings in the recent research studies into the role of ICT in undergraduate education (Butson & Sim, 2013; Sim & Butson, 2013, 2014). Results in those studies, demonstrated students' low levels of ICT use, which may be an indication that digital devices, such as computers and tablets, do not play a significant role in daily study practices.

Nevertheless, such similarities could also indicate that the participants might not have the computer skills that current literature assumes students at that level should have (Case et al., 2004; Wallace & Clariana, 2005). This is likely to be the case for the participants in this study. They exhibited only rudimentary awareness of, and skill in, performing tasks related to,

for example, file management, bibliographies, planning, databases and data analysis (see sections *5.2.2* and *5.2.3*). This finding aligns with the review of the existing literature (Castles, 2004; Dange, 2010), which reported low ICT skills of graduate students (see section *2.5.1)*. While the PhD student participants acknowledged the role of ICT in their academic practices, their capability to interact with ICT, particularly in the process of undertaking their doctoral research, was limited. In the current study, client-side applications designed to support research work, such as bibliography programmes (e.g., *Endnote*), organisation software (e.g., *OneNote*), data analysis packages (e.g., *NVivo, SPSS & MatLab*), and other applications such as generic time management and note-making activities (i.e., calendars, note-taking, and task applications) were noticeably absent from participants' daily practices.

The data also showed that the participants were relatively inexperienced users of available ICT tools and applications. Again, the implication is that these PhD students might not have acquired ICT skills that are needed to advance their research practice. For example, three of the nine participants – Jeremy, Mandy, and Patricia – had no idea how to use referencing software and were not convinced that the benefits of its use would outweigh the effort it would take to learn how to use it. There was a lack of awareness among the PhD students in using the mark-up facilities or embracing the storage and retrieval capabilities that digital formats offer. Much of the discussion about ICT in higher education literature proceeds from interlocking sets of assumptions (Jackson, 2005; Onilude & Apampa, 2010; Smith, et al., 2009) including that every doctoral level student has access to the same level of ICT and uses ICT in similar ways. Researchers such as Esposito (2014) show that the PhD students' learning to become researchers in the digital age is much more complex that these sweeping generalisations would suggest. Becoming a researcher involves developing a complex set of knowledge, intellectual abilities, techniques and professional standards. The Researcher Development Framework (Careers Research and Advisory Centre, 2010) illustrates one useful attempt at mapping out that complexity. It could be that PhD students' level of computer literacy for academic use has been overshadowed or taken for granted as a consequence of their advanced academic level. For instance, in this study Mandy admitted that she could study at PhD level but she did not know how to create a folder – a basic data management skill – for her documents on her computer devices. While Mandy was undertaking PhD study, her limited ICT skills could have been ignored or assumed by herself and even by her supervisors, who did not recognise or acknowledge the importance of such skills. It seems that the academically advanced phase of a PhD student is not necessarily commensurate with the level of computer literacy of that PhD student.

6.2.3 ICT use and the social system.

A considerable portion of the current literature on ICT use in academia suggests and assumes that student use of ICT will result in students being efficient in their learning (e.g., Smith et al., 2009). A number of studies claim that ICT now play a significant role in supporting undergraduate study (Aspden & Thorpe, 2009; Dahlstrom et al., 2011; Guidry & BrckaLorenz, 2010; Smith & Caruso, 2010). Data gathered through discussions with participants in this study echoed these claims, but the participants highlighted that the importance of ICT only exists when there is a specific purpose or motivation behind their use of certain types of academic application software that is directly related to what they saw as their doctoral research. For instance, in Patricia's case, if a software application was necessary help her to accomplish a task, such as data analysis, she would learn and use the related application (e.g., *SPSS*). In the circumstances of learning a non-research related application, such as *Outlook* calendar, she would choose to avoid learning it, despite the fact that she understood the benefits of using an electronic calendar for managing time or keeping track of appointments and so on. It could be argued that such a preference for learning one software programme over another reflected Patricia's limited proactive and long-term thinking, which could have motivated her to learn using both *SPSS* and *Outlook* as both of them could have been possibly beneficial in her PhD study as well as possibly important for her future career.

Having said that though, for most of the participants in this study, specific academic or research-oriented software applications were often viewed as having many features that needed to be learned – a difficult process – and adopted in order to obtain the full benefits in terms of facilitating efficiency and effectiveness. Some participants indicated feelings of intimidation towards academic or research-oriented software applications, and, as a consequence, exhibited a degree of resistance towards them. This was the case for Jeremy, Mandy, and Sam. Other participants, namely Charles and Patricia, who saw these applications as "heavy weight" applications that were complex platforms requiring commitment and time to master. ICT use did not always appear to reflect the individual daily research practices within the doctoral research process for this group of PhD students.

In addition, the findings also indicate that PhD students might not fully understand the best possible ways of carrying out doctoral research by effectively and efficiently using ICT. This could be best illustrated by Jeremy. Jeremy used *Microsoft Excel* to organise his bibliography instead of a purposely designed referencing software application, prompting questions about his meaning of efficiency and effectiveness, especially when it appeared that the production

of his dissertation was not being affected. Several pertinent reflections regarding Jeremy's graduate profile, including his preparedness for a future academic path or any other professional career, could be made. Once again though, can Jeremy's behaviours be criticised when he was technologically "savvy" enough to develop his own system to organise his bibliography using *Microsoft Excel*? It could be argued that the action itself suggests his efficiency and effectiveness at exploiting the potential for organising his references using a spreadsheet application. On the other hand, his ready dismissal of *Endnote*, as a purpose-built application, could be seen as his limited understanding about the efficiency and effectiveness that ICT can offer in his daily research practice.

In short, the way in which institutions, or more specifically, PhD supervisors, embrace and implement ICT could have a bearing on the way in which students engage with ICT in the context of higher education. Doctoral supervisors might need to be concerned that these students were not aware of how various ICT could support their doctoral research effectively and of the efficiencies that ICT can offer to them at different PhD phases.

6.2.4 ICT use and the technical system.

Various studies (Blignaut & Els, 2010; Ryberg & Dirckinck-Holmfeld, 2010; Shaw, 2000) suggested that graduate students' ICT use emphasised only the research preparation phase (e.g., *Google* search for searching information about the topic) and the writing phase (e.g., *Microsoft Word* for the writing of the thesis), as well as communication tasks (e.g., email for corresponding with teachers and classmates). This seems to align with the findings from the current study about the low use of research-related software applications. Nevertheless, the low use of these applications seems not necessarily to have had an impact on the participants' research outputs. The participants appeared to be achieving their goals, such as reaching their study milestones and publishing articles from their research work. Further, the way the participants were defining their goals was based on how they saw the "world" of the doctoral research process (the social aspect), especially the output of this process (the thesis). For them, the use of ICT was "output-centric": it did not matter how they used ICT; what counted was that the thesis was getting done.

Moreover, the PhD participants in this study appeared to define efficiency and effectiveness in a way that was different from the claims made in the literature about the possibility that their goals would be achieved in different and possibly better ways (Katz, 2003). These students were not motivated to explore efficiency and effectiveness in any way that would

involve hard work and extra effort. For them, the effort itself was constituted as inefficiency and ineffectiveness. The dilemma is then: how do students, who have the option to make use of a range of ICT, come to explore ICT and learn practices that are new and different to their well-practiced ways of working? The current claims in the literature seem to involve limited human factors when it comes to ICT use. Yet, the human factors are the key elements for a more effective and efficient way of ICT use. Without the input of human factors, ICT on their own could not support the development of human practices to their fullest potential in terms of being effective and efficient.

The findings in this study also suggest that, for these PhD students, ICT played a relatively insignificant role in the process of carrying out their doctoral research. These findings are different from the claim made by Smale and Regalado (2014) that the use of ICT happens "throughout [the students'] academic experience". It seems logical to conclude that PhD students have a consensus about the types of software applications that should be used, irrespective of their PhD phase or discipline background. Efficiency and effectiveness, which did not feature such consensus, are particularly obvious when the findings in this study suggest that the PhD students' use of ICT is intermingled with their daily life activities and is almost indistinguishable from their academic use. It appeared that certain types of software applications were more part of normalised behaviour than others in this process. The PhD student participants seem to "agree" with the types of software applications to be used or not used. It could be that the consensus is not based on a consideration of the efficiencies or effectiveness of ICT. This, again, demands answers about the roles that ICT are actually playing within higher education, particularly in the research domain.

6.3 The Notion of Socio-Technical in Higher Education

The four sets of ideas discussed in sections *6.2.1 – 6.2.4* highlight the tensions between the social and the technical elements of the student's doctoral research process. The findings from this study suggested students' expectations and interpretations of the role of ICT in the process of undertaking doctoral research vary greatly.

Figure 6.1 (in response to *Figure 3.6*) demonstrates this triangular relationship among a PhD student's social system, technical system and doctoral research process by suggesting that:

a. doctoral research exists within a social dimension (social system);
b. doctoral research relies heavily on ICT (technical system); and

c. these two systems are interrelated – As humans, technical system increases our capacity to perform tasks only possible through the use of ICT. However, access to these capabilities comes at a cost: ICT use requires a commitment to learning the particular processes and procedures.

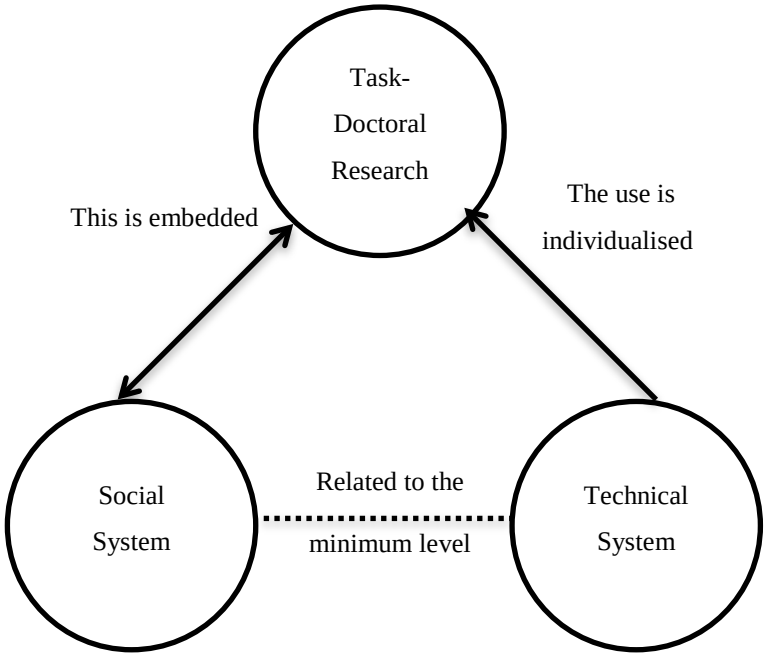


Figure 6.1. The relationship of the systems in the doctoral research process.

One way to unpack the interrelationships between the social and technical systems in regards to the process of doctoral research is through the use of four characterisations of Curation, Combat, Coping, and, Conforming (refer to section 5.3).

Curation (*a planned process of engaging ICT in undertaking doctoral research*): There was little evidence of purposeful appropriation of computer applications among all the participants. For example, both Patricia and Shaun chose to continue using non-digital approaches alongside their ICT use. Patricia's rationale was based on her fear of learning to use ICT, while Shaun, who had tried to adopt ICT struggled to do so and commented that he had decided to return to paper-based approaches as he thought too much of his time was being spent on learning how to use these applications. Both agreed they would have persisted if they had received support/guidance from their supervisors. It was interesting to see that supervisors' input regarding the use/support of ICT as part of the doctoral process was absent in all cases. As a result, the use of ICT was detached from their doctoral process.

Combat (*doubt about the importance of ICT*): Of the nine participants, seven had strong doubts regarding the relevance of computer applications to advance their doctoral research.

For instance, both Charles and Sam did not believe ICT use would enhance their doctoral research. Charles' rationale was based on his belief in his traditional paper based routines, while Sam expressed a lack of trust in using computer approaches, outside of a browser and word-processing application, for compiling his manuscript. Both indicated that they would have gained confidence in ICT use if there were ongoing support/guidance from their supervisors. It was interesting to see that supervisor input regarding the ICT use as part of the doctoral process was minimal in all cases. As a result, there were doubts about the importance of ICT use among PhD students.

Coping (*combination of a lack of capability with ICT and an ambivalence towards it)*: Similar to the previous characteristic, seven out of nine participants failed to see how increasing ICT use could add value to the doctoral research process. For example, Jeremy and Mandy were clear that their experiences with ICT to-date had been difficult and frustrating. Jeremy preferred pens and papers over struggling with ICT use, while Mandy was unaware of useful applications outside of *Word* and *Google*. Both expressed that they would probably have been benefited if research-related applications were a routine and normalised activity within their daily research work; such as through departmental or supervisor guidance. It was interesting to see that supervisors' input regarding the benefits of ICT use as part of the doctoral process was overlooked in all cases. As a result there were limited knowledge about the benefits of ICT to the research process among PhD students.

Conforming (*integration of behaviours applicable to ICT use)*: The limited ICT use shown by all of the study participants meant that research behaviours tended to be applicable to paper-based rather than digital processes. For instance, while Elizabeth, Steve, and Xavier created illustrations that suggested their practices had a strong alignment with ICT, the discussions revealed that their actual practice (daily behaviour) was not as "digital" in nature as implied. When raised, Elizabeth's rebuttal was that she was actually interested but resisted as she was slow in learning how to use computer applications. Steve and Xavier stated that to some extent they had changed their working behaviours because their areas of research required a greater use of computer applications than previous study. All three admitted that they would probably have invested effort to engage with ICT if its importance and benefits had been explained. It was interesting to hear that supervisor input regarding the adoption/engagement with computer applications was limited.

To summarise, while the students in this study felt that their ICT use was appropriate in this context, it did not lead them to use ICT in the best possible ways; at least not in comparison with the claims made about various ICT and software applications in the literature. Instead, the cohort's constructs of being efficient and effective led to tensions between their social and technical systems within the process of undertaking doctoral research. These tensions, however, could have been addressed through PhD students' social circles (see *Figure 3.4*) in this process, for example, through supervisors. After all, PhD students need "a guiding hand through the process of producing a thesis or doing a PhD" (Strengers, 2014, p. 548) and this includes the use of ICT in this process. The guiding hand of a supervisor would likely have an impact on changing student views and practices, as a supervisor is the one who "'observes, judges, instructs' while the students 'listens, tries and reports'" (Strengers, 2014, p. 548). Training in ICT use can be presented as "a predictable and orderly process of research skills training" (Grant, 2005, pp. 342-343).

6.4 Ongoing Tensions and Dilemmas

In light of the discussion presented so far, a number of questions regarding the ongoing tensions and dilemmas were highlighted.

Firstly, why are the students in this study struggling with ICT? At first glance, it seems to point to an issue of resistance relating to the perceived value of ICT to the doctoral process and the effort required to become competent in using ICT. However, as pointed out by Parkes, Reading and Stein (2013), "competency" is a term often debated in the literature (de la Teja & Bannan-Ritland, 2005). For example, the term makes it difficult to appraise the use these students made of ICT as either "competent" or "incompetent", given that their self-appraisals followed the criteria of "how well does this work for me". It is perhaps helpful then to view students' computer competency/literacy as a definition based on satisfaction rather than one based on technical or procedural conditions. Technical system, for instance, links competency to efficiency and productivity. From this perspective, technical approaches demand an adherence to procedural and systematic methods as opposed to beliefs and feelings.

From a social perspective, in light of the socio-technical framework, computer literacy is a construct that is relevant and authentic to particular social systems (norms/beliefs), and can only be measured within that particular perspective. As explained in section *3.4.2.1*, a particular social system refers to entities in definite relation to each other, which sustains patterns of behaviours within a particular contexts (Bronfenbrenner, 1979). In the context of

the doctoral research process, beliefs and norms become embedded in the students' social system in such a way that they also shape the behaviours of the students within the system. There are, however, also norms and principles embedded in the technical system. Referring to the technical system as demonstrated in section *3.4.2.2*, the idea of "progress" propels the world of ICT. For example, from the technical point of view, the functionality, reliability, and availability of ICT are dynamic concepts in a state of "progress" at all times and as such "progress" underpins the notion of efficiency and effectiveness in terms of productivity. Therefore, the normalised behaviours of competency in ICT use that are relative, and based on the construct derived from the social system, contradicts the normalised progress in the technical system. Such a contradiction creates ongoing tensions and dilemmas between the social and the technical system within a context.

Secondly, is there a process of teaching and learning ICT use to achieve learning outcomes of computer literacy within academic contexts? As stated by Gourlay and Oliver (2012), the idea of "learning" has been widely theorised in research but not in relation to "educational technology" teaching and learning. In this context, why is ICT teaching and learning not being embedded explicitly in higher education, especially at the PhD level? The overriding assumption is that because PhD students are advanced academically, they will therefore also be advanced in the use of ICT. The lack of educational support and training for ICT use is somewhat perplexing in an environment where ICT are used in every aspect of its practices; from planning, writing, fieldwork and analysis. Perhaps it could be more fruitful to discuss what the ICT needs of PhD students are in the doctoral research process, how supervisors could respond to those needs, and what they need to know in order to do so, as well as how ICT teaching and learning could be designed to be responsive to the needs of students carrying out doctoral research. Thus, it is these aspects of academic development of ICT use that come to the fore when students articulate the "usefulness" of ICT as evinced in the findings of this study. In short, from the perspective of the social within the socio-technical framework, ICT use is both social and technical in nature and social and technical in practice. The needs (in terms of the selection of ICT use for PhD students' doctoral research in this context) and the outcomes (such as the measurement of the completed tasks versus the process of completing tasks), however, are usually situated within the construct of "a student's comfort zone" ignoring the efficiencies and productivity benefits offered by ICT.

A third question relating to the context of this study concerns the doctoral research. How cognisant are students of the processes required to succeed in doctoral research? According to

Park (2005), PhD study is "a socially constructed encounter rather than a fully objective and impartial process" (p. 196). This means that the nature of doctoral research is subject to interpretation. How a PhD student conceptualises his or her study will have an impact on how he or she uses ICT in this process, and that conceptualisation will determine and influence how students use their energies and concentrate their efforts. This could result in a focus on completing the thesis in the way they currently believe it should be done and neglect learning other skills, such as how to use ICT in this process, which could in turn enhance their achievement of that goal. Supporting this approach, PhD students would then use ICT in way they assume to be the best possible ways (e.g., ICT as a knowledge consumption platform), thus re-confirming their current constructs of being efficient and effective in using ICT for this process. Therefore, it is worthwhile to acknowledge and work with the diversity and variety of ways in which PhD students carry out their doctoral research as well as the ways they engage with ICT. However, such effort could result in two different outcomes. There is a possibility that PhD students could embrace the idea of re-developing their use of ICT in relation to their doctoral research, or they could ignore the advantages that ICT have to offer. Again, this will depend on the degree to which they, through their social system, have come to believe in, or not believe in the power of ICT to augment activities such as research. Perhaps then there is a need to pay closer attention to how PhD students construct the notion of PhD study in order to understand further the ways they use ICT in doctoral research, and associated with this, how they define best possible ways, efficiency, and effectiveness.

6.4.1 ICT and the notions of "efficiency", "effectiveness", and "best possible ways".

The notion of the best possible ways or best practice in using ICT is not something that can be packaged and defined (Inglis, et al., 1999). What is often deemed to be best practice comes about through social mediation, which follows negotiations within a social system about what constitutes and counts as the best possible ways or best possible actions in carrying out a task. This is particularly true in regard to being efficient and effective. However, the best possible actions in relation to being effective and efficient are "independent of any foundational reality", where there is no existence of an "objective" truth (Guba & Lincoln, 2001, p. 1). These ideas are reliant on an appreciation of the mediating processes that hold the relationships of reality and truth together. Yet, this is not the case in the technical system. The ideas of efficiency and effectiveness could be considered straightforward within the world of ICT. This is because ICT development strives to improve constantly and becomes better as well as more advanced in order to further develop the society. Such a state of constant

progress in the technical system, as mentioned earlier, challenges the negotiation of the notions of efficiency, effectiveness and the best possible ways that are constructed in the social system.

In this way, the tensions between the social and technical conceptions of efficiency and productivity associated within the process of undertaking doctoral research are challenging. Arthur's (2009, p. 28) three definitions of technology capture these challenges situation well:

1. "Technology [is] *a means to fulfil a human purpose*", which implies that ICT should be able to fulfil a PhD student's purpose in accomplishing doctoral research in the best possible ways.

2. "Technology [is] an *assemblage of practices and components*", which indicates that ICT should be able to provide navigation in order to support a PhD student in the process of undertaking doctoral research in an effective and efficient manner.

3. "Technology [is] the entire collection of devices and engineering practices available to a culture", which points to the fact that ICT should be embedded in the culture of carrying out doctoral research.

As explained in section *2.3.3*, in a balanced system, there should not be tension between the PhD students' social and technical systems in the doctoral research process for optimal outcomes to be achieved. After all, ICT for academic purposes are devised or envisioned by academics for academics; by human beings for human beings, and therefore, it could be considered "logical" that any tension between humans and technologies should not exist.

Following on from these bases – the definitions of technology and the principles of achieving optimisation through a balance between the social and technical systems – ICT should be applied to education (doctoral research in this context) in ways that acknowledge and recognise related and associated human purposes for the technologies deployed (Jones, 2013). While ICT could be viewed as being situated in the complex socio-technical systems within in the doctoral process system, ICT learning should be embedded within the culture of this process.

The discussion in section 6.4 so far suggests that tensions and dilemmas among the links between the social and the technical systems could be resolved by adopting a shared construct for these ideas as they relate to ICT use in doctoral research practices. Based on the

phenomenon of ICT use by PhD students as represented in this study and shown in *Figure 6.1*, the links causing tension and dilemmas are now included into a re-constructed *Figure 6.2*.

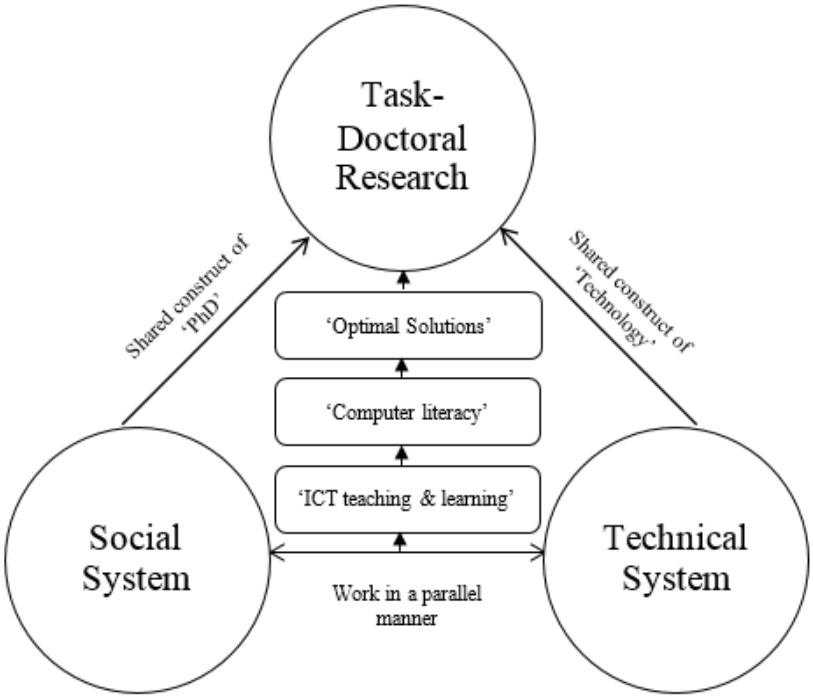


Figure 6.2. The proposed doctoral research process in the light of socio-technical framework.

First, *Figure 6.2* shows that, in the context of PhD study, there could be a shared construct of a PhD (the social system). The construct of a PhD could be set at an institution level. This construct would then influence the ways academic departments, and thus doctoral supervisors and PhD students in those departments, view and understand the PhD. The existence of such a construct is useful, as it would determine the ways ICT is used in a doctoral research process. At the same time, instead of normalising the existing taken-for-granted and/or overlooked assumptions about the role of ICT in the doctoral research, perhaps it is time to re-construct and then "re-normalise" the concept of "the role of ICT" in this process (the technical system). By having these two constructs "re-built", the social and the technical systems could work in a parallel manner in the doctoral research process, towards the goal of accomplishing a doctoral dissertation in the notion of "the best possible ways". This parallel relationship could be beneficial in the generation of an optimum educational outcome, in terms of increased productivity of work as well as increased effectiveness and efficiency. This optimum outcome can be achieved if both social and technological elements work together within a context, as described earlier in section *2.3.3*.

The constructs of doctoral research and technology, with student perceptions focused on "needs" and "outcomes" related to "satisfaction" and "comfort" in relation to ICT could be challenged to embrace efficiency and productivity by introducing a level of academic development focused on application use to support the research process. This would then lead to increases in "computer literacy" promoting changes in thinking and practice, leading to "optimal solutions" in accordance with both social and technical agendas. This would result in a greater understanding and appreciation of the mediating processes that hold this relationships (social system and technical system) together in activities, such as doctoral research. Based on social negotiation, this construct would be able to mediate assumptions about efficiency and effectiveness, within the research context, as well as to echo the aim to achieve an optimum educational outcome.

6.5 Conclusion

The review of the socio-technical schema in the context of this study, as well as in the broader higher education context as discussed above, responses to the research questions that appeared in sections 1.1 and 6.1 through the reflection in the discussion presented in this chapter, are summarised:

1. PhD students in this study used ICT at a minimum level of time for their perceived maximum capacity within their understanding of the best possible ways to support their doctoral research.
2. PhD students' assumptions and expectations of ICT as well as their ICT practices were based on their social definition of how ICT is used to support their doctoral research. They were not comfortable with taking up the cost of increasing their access to ICT, which would then increase their capacity to perform tasks in this process.
3. The ICT assumptions, expectations, and actual practice of PhD students and related claims concerning the role of ICT documented in the research literature reflected the limited ICT adoption among PhD students. In contrast to the social definition of ICT use, the technical point of view indicates that ICT use requires learning and time investment in order for PhD students to maximise the capabilities of ICT to increase their efficiency and effectiveness in the process of undertaking doctoral research, but this was not shown in this study.
4. The tense relationship between PhD students and their ICT use as presented in this study may be beneficial for different communities (the institution, the disciplines, the lecturers, the supervisors, and the students) through:

a) questioning the notion of computer literacy;
b) de-mystifying the construct of ICT use among PhD students;
c) scrutinising the idea of PhD study;
d) exercising possible optimal solutions for ICT use in the doctoral research process; and
e) interrogating the tension that exists between the social and technical systems within doctoral research.

Different communities ought to understand that changes are needed (e.g., ICT teaching and learning) in order for PhD students to gain benefits from ICT use for carrying out their doctoral research in the best possible ways.

The conventional acceptance of students in higher education as being computer savvy has meant that very few critical studies concerning computer literacy have been conducted. This taken-for-granted view has resulted in the lack of attention and/or intervention regarding research into the appropriate use and acquisition of digital applications and devices to advance doctoral research processes. The current neglect of this research has resulted in a missed opportunity. Arguably, this field would be enriched by greater attention of one major concern: the relationship between the social aspect and the technical aspect in the context of higher education, which includes the consideration of the dilemma or the tense situation from the social aspect while adopting ICT.

The next chapter concludes this thesis by looking back on the process of this study and by looking forward to consider the next steps to explore as well as to enhance students' use of ICT in higher education.

Chapter 7: Summary, Conclusion and Reflection

7.1 Introduction

This final chapter will summarise the study, outlining its implications and relevance in the context of higher education as well as in the broader research field. Following this, suggestions for further research are offered to conclude the chapter.

7.2 Summary of the Study

7.2.1 The overview of the study.

ICT are now woven deeply into the fabric of teaching and learning processes in higher education (Henderson et al., 2015). This is particularly true for PhD students for whom ICT are essential for their day-to-day research practices. However, there has been little research to date that explores PhD students' first-hand experiences of using ICT to support their research practices. Therefore, the focus of this study was to explore the PhD students' use of ICT to support the process of their doctoral research, within their context(s).

The existing literature in educational technology research has paid scant attention to the incorporation of theoretical frameworks that might be useful to frame and inform the research in this field. In addition, the related educational technology studies that do exist are limited in terms of the research methods used, and as such, might be restricting opportunities to advance knowledge in this research field. Drawing on the literature, the study presented in this thesis introduced the idea of incorporating a socio-technical framework (Trist et al., 1963), underpinned by an interpretive, social constructivist, naturalist enquiry and analysis approach as proposed by Guba and Lincoln (1989). The socio-technical framework created a coherent and bounded scope for both the social aspect (PhD students) and the technical aspect (ICT) in order to demonstrate the relevance of ICT to higher education, as well as to help understand the social and the technological dynamics within students' academic practices. The framework illustrates the potential value of accommodating the needs of specifying and advancing the understanding of both social and technological aspects in a university context.

To reflect the methodological underpinnings of the study, as well as to acknowledge and recognise the complexities involved in the relationship between students and technology, the study incorporated a number of different data collection methods. While Dataset-1 (computer activities) in this study determined what was actually used by students (e.g., software

programmes and/or websites) to support their daily research practices, Dataset-2 (participative drawings) showed how PhD students expressed their views about and defined doctoral research, and provided an opportunity for them to share their reflections about ICT use in this process. At the same time, Dataset-3 (interactive data) involved the students' demonstrations of ICT use and their perspectives on the role of ICT in their process of carrying out doctoral research. This occurred individually as well as in a group setting alongside photographs that captured images of their work spaces. These three data sources were drawn upon to ensure that claims made about the students' understanding and use of ICTs were consistent with a variety of data.

The researcher worked with the participants over an extended period of time (prolonged engagement), focused on observing and monitoring identifiable, as well as documentable aspects, of ICT understanding and practice (persistent observation), and employed techniques of a hermeneutical dialectic cycle that incorporated peer debriefing, member checking, analysis and fair presentation of assertions (Guba & Lincoln, 1989).

7.2.2 The key findings of the study.

The findings suggested that the participants' limited ICT use, regardless of their PhD phase and broad discipline background, might have reflected their inability to realise the advantages of learning how to use current ICT devices, tools, and applications to enhance the process of undertaking their doctoral research. The evidence that emerged in this study indicated that participants avoided learning about and using ICT during their doctoral research process, especially when there were perceived challenges or difficulties for them. In the discussion it was argued that the boarder higher education sector, such as the institutions and the supervisors, might have overlooked or taken for granted the PhD students' ICT capabilities in this process. The PhD students' ICT actual practices were different from common assumptions and expectations as reported in the literature.

Another finding that surfaced from the study is that the socio-technical systems in the doctoral research process, as related to the PhD students' goal-directed behaviours of producing a doctoral thesis in the best possible ways, are co-adopted and co-adapted to each other minimally. While the social system is embedded in the doctoral research process, the technical system is individualised in that process. The participants were not aware of the extent of their use of ICT in their daily academic practices. The study raised their awareness of this through computer activity capture by *ManicTime*, however, this newly gained

awareness did not appear to change the participants' behaviour dramatically. It did provide a degree of self-awareness about their computer usage though. Such an unexpected outcome from the study reveals that there could be a strong possibility, if opportunities are made available, for students to experience a kind of "education technological transformation" within their learning process at the university. This may be particularly possible when the students' behaviours are exposed to them through studies such as this one, so that their overlooked or taken-for-granted behaviours are made explicit. The different involvement, interactions, and perspectives between the past and present, before and after taking part in a study like this one, could lead the students to re-reflect on, or even change, their practices.

On the other hand, the computer literacy level of the PhD student participants in this study were low. The perspectives and behaviours demonstrated by the participants showed that they would benefit from technological support to help them gaining an awareness of their actual competence in using ICT and of the possibilities of research-related and other kinds of software, in order to enhance their research practices. For example, their limited use of research-related ICT could have been due to their limited knowledge of the types or functions of certain software applications for use in their research practices. As the findings showed, PhD students need to know the purposes and the benefits of, or to have the motivation to use, certain types of academic application software in their daily research practices. It seems that then continuous education technological transformation through involvement studies like this and other training activities could have an impact on changing students' perspectives and behaviours related to ICT use.

Last, individual PhD students presented differences in their ways of using ICT when undertaking their doctoral research. The characteristics of Curation, Combat, Coping, and Conforming situated within the context of PhD students' ICT use in their doctoral research in relation to their notion of best possible ways to be efficient and effective.

7.2.3 Conclusions.

ICT is unable to replace human beings in many ways but the invention of ICT could promote a better working and living environment for human beings. Nevertheless, in terms of efficiency and effectiveness of using ICT in academic practices, the notion of the best possible ways of using ICT from the higher education perspectives could be enhanced. For example, if a PhD student was aware of the benefits of using a referencing software application (e.g., *Endnote*) and was willing to take up the challenge of learning to use it, his or

her research practices would become more effective and efficient. Otherwise, how these emerging academics researchers (if they choose to take up academic career path) would support future students is concerning. In a way, it is less ideal to have the same phenomenon (i.e., the ways of using ICT as represented in this study) being repeated. In the light of these reflections raised in this study, the much-discussed use of ICT in students' daily routines is related to the notion of computer literacy and the role of ICT in education that are not always apparent in the day-to-day use of ICT in academic practices.

As mentioned in section 6.4, the use of ICT in the process of undertaking doctoral research is socially constructed by students, supervisor(s), and increasingly, academic departments, universities, or even the funders. Thus, there is no "fixed" way of using ICT within doctoral research. As illustrated in this study, there were challenges, tensions, and dilemmas involved in the use of ICT in the PhD students' processes of carrying out doctoral research. An insight into their understanding of ICT use in this process could therefore be beneficial as a guide in the process of supporting PhD students' use of ICT in their daily research practices. For instance, students and supervisors can hold different assumptions about the use of ICT. Supervisors may assume that students know how to integrate research-related ICT into the research process and consequently not discuss ICT use during the period of supervision with the student. At the same time, students may assume that their computer literacy is sufficient when supervisors do not mention anything about this. Thus, students might assume there was no need to develop their skills further. Or they can choose not to seek help with ICT use as they may feel the expectation of the supervisor is for them to be competent in ICT use. In short, the "expectation gap" between the supervisor and the PhD student can lead to particular ICT use. This study therefore highlights the extent to which assumptions and expectations can result in the students' behaviours in terms of ICT use that were observed. At the same time, the study was designed in such a way as to explore the degree to which a PhD student's ICT practices are informed by their assumptions and expectations in doing doctoral research.

Drawing on the themes that emerged from the literature and the core findings from this study, the overall emphasis of this study relates to the theoretical approach used: the socio-technical framework. The relationship between human beings (social) and ICT (technical) is complex when considering the links between the two elements and exploring beliefs and behaviours of human beings who are using the "human invention" of ICT to achieve a goal. This relationship becomes tense, particularly when the human beings (the PhD students) express preferences about how to use these inventions (ICT) in the process of undertaking doctoral

research. Furthermore, in the context of doctoral research, the outcome or the end product of the process – the thesis – becomes emphasised more than the process itself or the person engaged in the activity. Tensions between PhD students (social) and ICT (technical) exist due to the normalised or taken-for-granted construct of the role of ICT and the emphasis and importance that is placed on the end product in the doctoral research process. Such a construct determines PhD students' ICT practice, and thus their practice also informs their perspectives on ICT in terms of what constitutes the best possible ways in carrying out doctoral research; they cannot "see" and understand a "world" beyond their own experience. As proposed in *Figure 6.2*, the tension within the link between the socio-technical in higher education may be resolved if a "shared" forward-looking construct is adopted in the following areas:

1. What a PhD study is (the social system);
2. What the role of ICT is (including potential and possibilities beyond the current role) in the doctoral research process (the technical system);
3. How to enhance ICT teaching and learning at university level;
4. How to define computer literacy in higher education; and
5. The understanding of the optimal solutions.

7.3 The Limitations of the Study

Involving a small cohort of student participants and only focussing on PhD students' use of ICT as represented in this study could be seen as limitations to the research. However, the small number of participants and the much-focussed concentration on ICT use as part of students' doctoral research process enabled a range of data sources to be drawn upon and a deep analysis to be undertaken within context. The research design and the methodological foundations of this study aligned well with the size and nature of the investigation. At the same time, the investigation and its aim were framed around the PhD students' use of ICT and thus, the study did not examine the individuals or the groups who are associated closely with PhD students, such as the doctoral supervisors or the PhD peers.

7.4 The Implications of the Study

Focussing on the elements of social and technical from the socio-technical framework, this section will present the implications for the participants, the supervisors, and the academic

disciplines, the higher education institutions as well as the educational technology research domain based on the summary of the study.

7.4.1 Implications for the participants.

The data in this study indicate that participants had adopted the same pattern of educational practices prior to the invention of ICT. Despite the access to ICT in higher education, they were, to a certain extent, resistant to changing their methods of working without making necessary adaptations. While it is acknowledged that adaptation takes time, it is important for PhD students, who are at an advanced academic level, to continually review, revise, and improve their research practices based upon current and anticipated future needs. After all, PhD students are considered to be emerging independent researchers (see section *2.4.1*). As questioned by Wellington (2012), is doctoral research largely about the process (i.e., the learning and research development) or is it mainly about its product (i.e., the doctoral thesis)? In this case, what PhD students learned in the past is valuable and it should be applicable to current needs, but most importantly, the students cannot blindly continue the practices that might become vulnerable and ineffective now and in the future, such as the ways of using ICT. PhD students should be proactive by taking up opportunities to learn using various ICT effectively and efficiently during the doctoral research process whilst not neglecting the outcome (the thesis production).

7.4.2 Implications for the supervisors and academic disciplines.

The findings from this study provide an opportunity for academics, especially supervisors of graduate research students, to question the extent ICT play a role in PhD students' research processes, and the nature and extent of technological support that might be required to support PhD students. It is clear that the supervisors need to look beyond their own experiences and promote ICT use actively. They ought to be aware that PhD students should be given support to optimise their use of ICT. For example, supervisors could bolster PhD students' positive thinking about ICT use or even take the initiative to introduce research-related software to PhD students without any prior assumption or expectation during supervision. As the same time, PhD students ought to realise that their justifications for not using certain research-related application software does not present themselves as being smart or innovative, but an indication of their lack of confidence to learn the advanced technologies. In order to achieve this, the supervisors who work closely with the PhD students could play a major role in supporting students' use of ICT in their day-to-day research practices. Alongside this, academic departments in the various disciplines could run workshops on ICT use for research

practices. While it is often the norm for such workshops to be run at the institutional level, they can be generic rather than specific to individual PhD students' needs. Workshops based at the department level would be better placed to make connections between the academic discipline community and the students' research learning needs. Reflecting on the levels of the social system in which the PhD students operate (see *Figure 3.4*), there will be a bigger influence and impact on the students at the supervisors and academics disciplines level. Even though it was not a focus of this study, there was some indication that the role of supervisors and departments in supporting students' ICT understanding and practices may warrant further exploration.

7.4.3 Implications for the higher education institutions.

Data from the study revealed that the diverse perspectives on efficiency and effectiveness in academic work held by PhD students could be barriers for optimal use of ICT. The findings imply that the ways PhD students choose to use ICT is based on their perception of being effective and efficient. But when certain types of applications or use of ICT are commonly agreed upon, they become a norm, in the same way as word-processing software for writing and creating written documents is seen. In contrast, if a software application is not commonly recognised and used, PhD students may just compensate or substitute for the use of that software by focusing on the end product (the thesis) and not explore the software use even though the process overall will be as not as efficient and effective. Therefore, in order to achieve this shared sense of ICT use, institutions could articulate a vision about the role of ICT, and ensure that the vision is communicated clearly and embedded in institutional practices. Part of such a vision would be to emphasise the need to focus on the process of undertaking doctoral research, as well as the outcome of the process.

7.4.4 Implications for the educational technology research domain.

The practice data, as presented in this study, contributed to the exploration of the manner in which one group of PhD students integrated ICT into their doctoral research, and the ways they used ICT in order to support and develop their research practices. The potential of methods focused on capturing naturally occurring data compared to gathering post-event recollections through student self-reporting is significant, especially in the educational technology research domain. As discussed in section 2.6, not only have the studies that employed perception data presented different scenarios of students' use of ICT, but they also concealed what students actually do in practice. Student perceptions and post-event recollections could be quite different from their daily practice. In addition, applying an

interpretive approach meant this study took into account the diversity that exists across groups of individuals (in this case, the PhD student participants). This allowed a deeper analysis into the phenomena that exist within the context. Therefore, from the points of research design and methods, perhaps authentic and situated behavioural data, as well as an appropriate theoretical framework, could be engaged in researching educational technology, particularly students' use of ICT for academic purposes.

7.5 Relevance of the Study

Drawing on both perception and practice data, this study was an investigation into the role of ICT and its usage in the research practice of PhD students. It aimed to provide insights into the context(s) in which PhD students integrate ICT into their daily academic practice, and the ways they use ICT to support and develop research work. In this context, students' ICT experience, attitudes, and strategies were explored drawing on three datasets (see Chapter 4).

The outcomes of this study will help to inform the growing literature on graduate students' authentic research experiences related to the use of ICT. The findings are relevant to the broader tertiary population in that they will help to engender awareness about students' ICT practice and behaviours with ICT, and prompt thought about the extent of the role that ICT plays in PhD students' research lives. This study has informed the approach regarding the use of ICT in a wider higher education context where there is an opportunity to re-evaluate ICT teaching and learning at university.

In addition, this study adds another voice or aspect to the growing interest in the role and impact that ICT are playing in education, particularly in terms of the use of the socio-technical framework in this study. The framework was useful for shaping this study, and more broadly, for investigating the connections between humans and ICT. Furthermore, the socio-technical framework has not been used in an educational field in this way previously and it has enabled an exploration of a set of phenomena in a different way than in other documented research studies. As a result, the use of the framework facilitated the ability to draw out understandings and insights that other research in this field has not done before. It is hoped, therefore, that this study will promote a deeper conversation in the context of higher education, as well as in the broader research field about the role of ICT at a tertiary level and the use students currently make of ICT devices and applications to support their study.

7.6 Future Directions

Directly associated with the outcomes of this study, future studies could focus on:

- the computer literacy of PhD students and its association with ICT integration into their research processes;
- how ICT is integrated in students' daily academic practices, as in this study;
- the assumed role of ICT as a knowledge consumption platform among tertiary students;
- the PhD students' ICT use and its association with their graduate profiles,
- ICT use by larger and more diverse groups of PhD students at institutions outside New Zealand; and
- projects that make use of authentic and situated behavioural data concerning technology use, in order to shift the generally accepted research approaches that tend to rely on post-event self- reports in the way to understand and gather data in this emerging field.

Future studies could also explore the role of research students, supervisors, academic departments, and institutions in supporting and enhancing students' practices and beliefs about ICT in research processes. It would also be worthwhile to investigate the ways in which supervisors engage ICT in their daily academic practices, with a view to exploring how, or if, their ICT use is an influence on PhD students' beliefs and behaviours in using ICT.

Studying ICT in these directions could offer fresh perspectives and opportunities to think differently and reveal new ways to research ICT. These will provide an active way of understanding the phrase, "the role of ICT in higher education"; that social accounts emphasise how different communities, such as institutions, disciplines, lecturers, supervisors, and students, are not simply caused to act by ICT, but are well-positioned to make sense of ICT and integrate ICT meaningfully into academic practices in an active way, and through doing so, embed the role of ICT in higher education.

Post Autobiographical for the Study: *So What?*

"So What?" ☺ - Yes, it is the favourite question asked regularly in academia and yes, I have been answering this question since the first day I started undertaking my PhD study. Half way through my PhD study, I asked one of my supervisors if I have to answer this question in an on-going manner – YES is the answer. What?! Why?! Don't we know that this question and answer is endless, especially in the research domain? Some more, from a social constructivist's perspective, everything is relative and arguable at all times. How could I provide an answer that will satisfy everybody? My naïve thinking is that perhaps one should try to see things from my perspectives in order to end the "So What?" questions. After all, I have now written 7 chapters to address this question! Obviously, I know there will be more questions to be answered from this study but isn't this what research is all about? One study is done and thus, another study emerges to continue the highlight of the former as well as to create another climax for the latter. Or perhaps I am wrong. I might be too ignorant in this aspect as I actually need to be answerable to this question at all times. Sigh, oh well then! Maybe this is a 'socially constructed' question and it has reached the consensus within academia to be asked all the time in order to generate the so-called scholarly discussions. But at this very moment, I think I am done TEMPORARILY for the "So What?" discussion for my topic in this doctoral dissertation.

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Appendix 1: An email of description and invitation for participants' recruitment

Hi,

I'm KwongNui Sim, a PhD student at Higher Education Development Centre, University of Otago.

I am researching 'An Investigation into the way PhD students utilise ICT to support their research process'. As part of my PhD research project, I am looking for 12-15 volunteers to participate in my study as advertised below.

SEEKING PARTICIPANTS

Have you ever wondered how you adapt ICT into your PhD research process?

Do you want to know how ICT is integrated into your PhD research process?

IF SO,

YOU are invited to participate in an "ICT Perception-Behavioural" Study

What type of participants are being sought?

· On-campus full time PhD students regardless any stage of your research process.

· Individuals with NO history of deferral before.

This study has been approved by the University of Otago Human Ethics Committee (Ref No: 13/219).

If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256) or email gary.witte@otago.ac.nz).

Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

If you are keen to participate, please send me an email at kwongnui.sim@otago.ac.nz and I will provide you with more information on the study.

Kind regards,

KwongNui Sim (Supervised by Dr. Sarah Stein;

Co-supervised by Russell Butson and Dr Jacques van der Meer)

Appendix 2: All nine participants' questionnaire replies as part of the recruitment process

Questions 1-5

1. My discipline background is

2. What is your current research phase? Circle as many as it suits.

3. Please indicate the ratio (within 10) of how much your workload is according to the research phase that you have chosen in question two. For example, write 5:5 if you have a balanced workload between Analysis Phase and Write-up Phase.

4. How do you rate your ability to use ICT?

5. What is your selection of ICT devices, tools and networks for use in your PhD work? Please use the spaces to add others.

Replies for Questions 1, 2, 3 & 4

	A	B	C	D	E	F	G	H	I
1			Q1		Q2		Q3		Q4
2									
3	Charles		Science		Preparation, Data Collection & Analysis		1:4.5:4.5		Fairly
4	Elizabeth		Health Science		Preparation & Data Collection		5:6		Fairly
5	Jeremy		Humanities		Write up		10		Fairly
6	Mandy		Humanities		Write up		10		Fairly
7	Patricia		Science		Preparation		10		Fairly
8	Sam		Commerce		Preparation		10		Fairly
9	Shaun		Science?		Preparation & Data Collection		7:3		Fairly
10	Steve		Science		Data Collection, Analysis, Write up		1:2:7		Fairly
11	Xavier		Commerce		Preparation & Analysis		5:5		Fairly
12									

Replies for Question 5 (List of Devices and Networks)

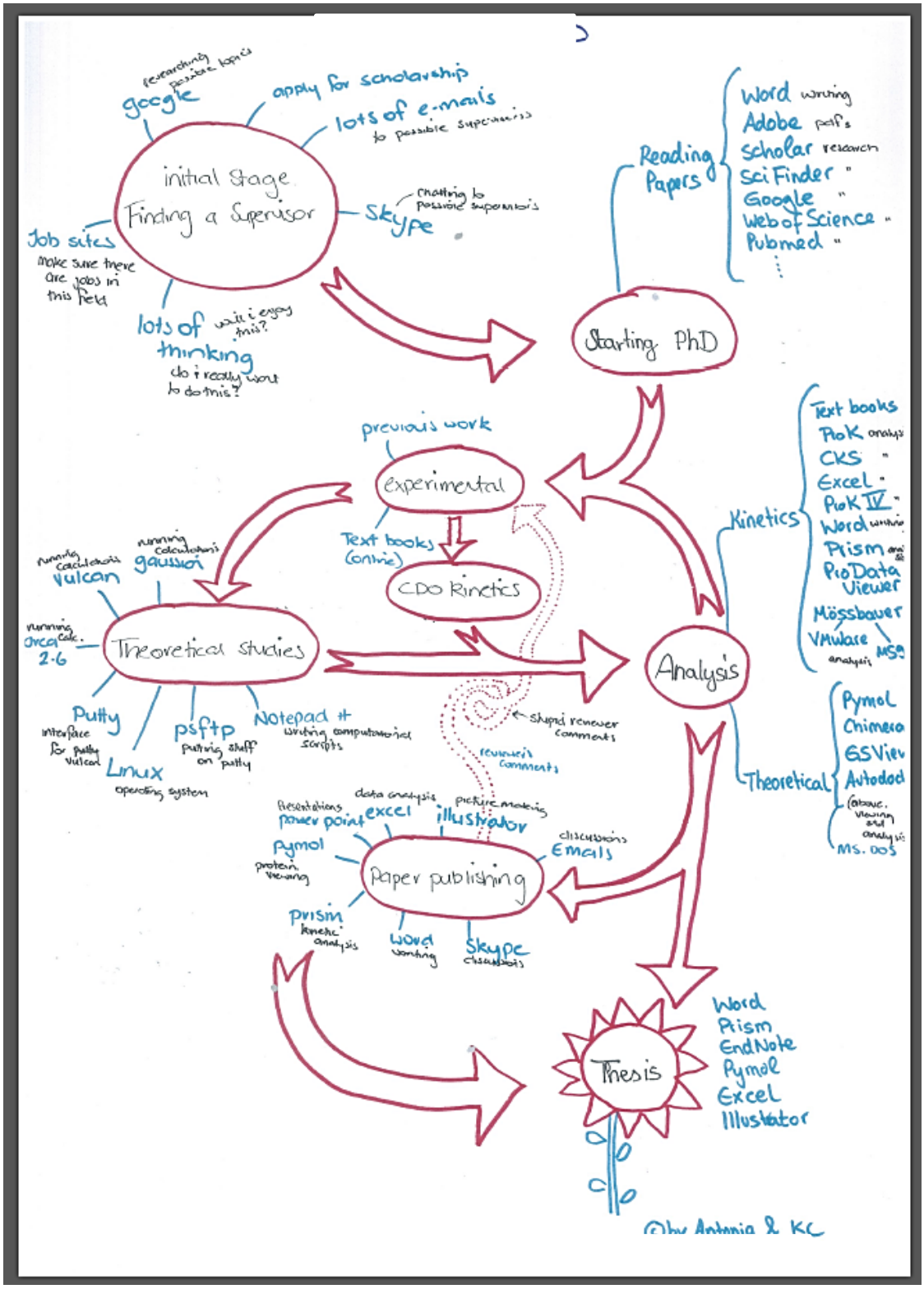
J	K	L	M	N
	Q5			
	desktop, laptop, ipad, smartphone		Uni & Vodafone	
	Laptop, Desktop, Smartphone		2 degrees, Uni & Polytech	
	Desktoop and laptop		Uni	
	laptop		Uni & Vodafone	
	Desktop and laptop		Uni, Private & Vodafone	
	iPod, Smartphone, Desktop, MacBook		2 degrees & Uni	
	PC and NB		Uni & Vodafone	
	Office computer, Lab computer, Laptop, Smartphor		Uni & Vodafone	
	Laptop, Desktop, Smartphone		Home, Uni & Vodafone	

Replies for Question 5 (List of Tools)

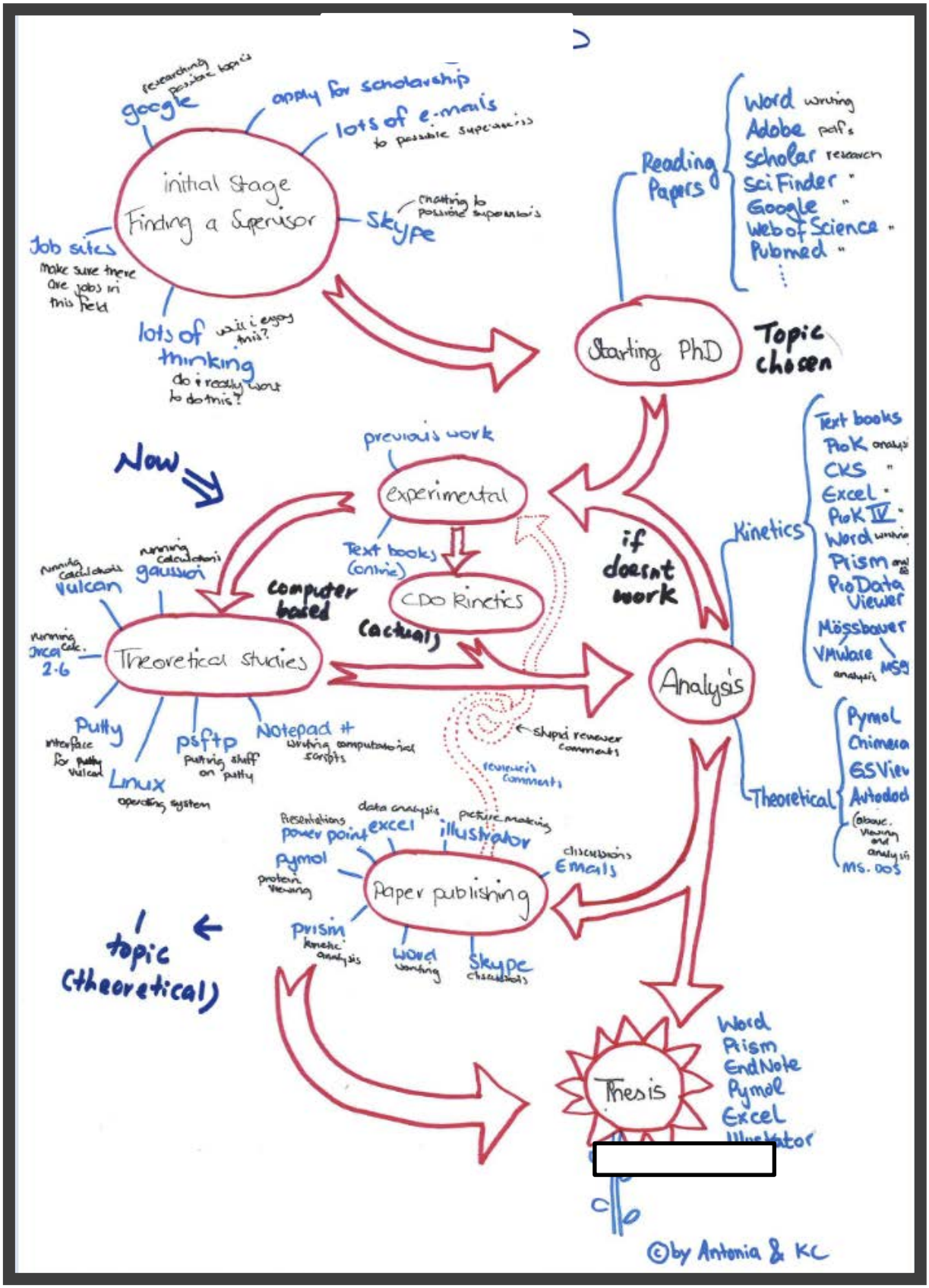
O	P	Q
GraphPad Prism, Full microsoft suite, Pymol, Chimera, Skype, Pro-Data SX/Viewer/Kinteticist/KIV, Gabetic, Gaussian, Orca, Endnote, ChemDraw, NotePad++, Putty, PyMOL, Vina, Adobe Suite, VMWare, Vmoss, Gociew 4.7, gOpenMol-3		
SPSS, Endnote, box, Dropbox, Google, Prezi, Social networks (Twitter, Linkedin, Academia, ResearchGate), Microsoft		
ArcMap(GIS), Word, Freehand (Micromedia)		
Excel, PowerPoint, Adobe, Word, Email, Skype'		
SPSS, Microsoft, Matlab		
SPSS, Acrobat, Office, Skype, Dropbox, Databases		
Python, R, Matlab		
Word, Excel, PPT, Matlab, Ccompex, Metaflour, Email		
Matlab, Pyton, Android		

Appendix 3: Participants' three-tier drawings

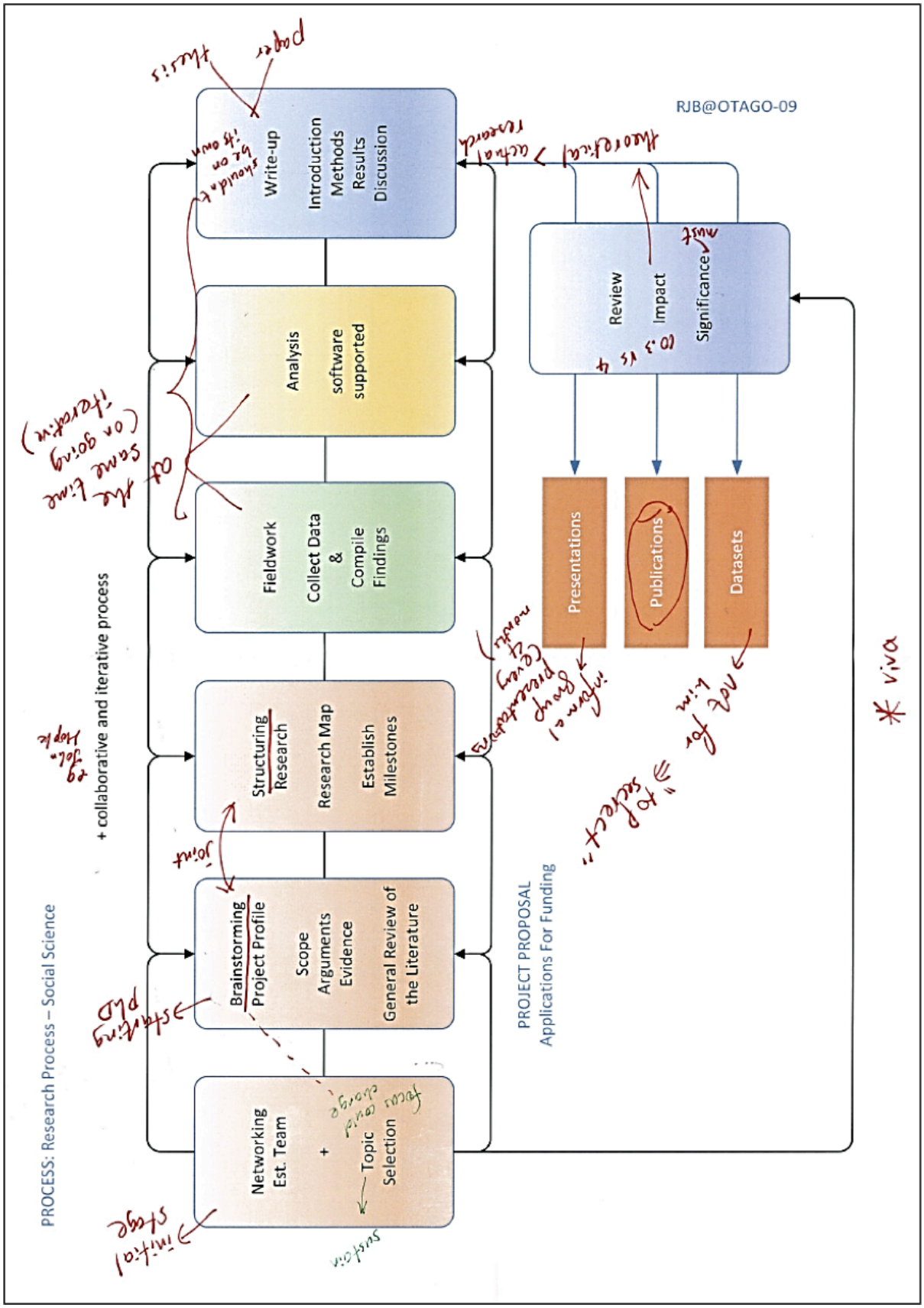
Participant-1: Charles's Drawing



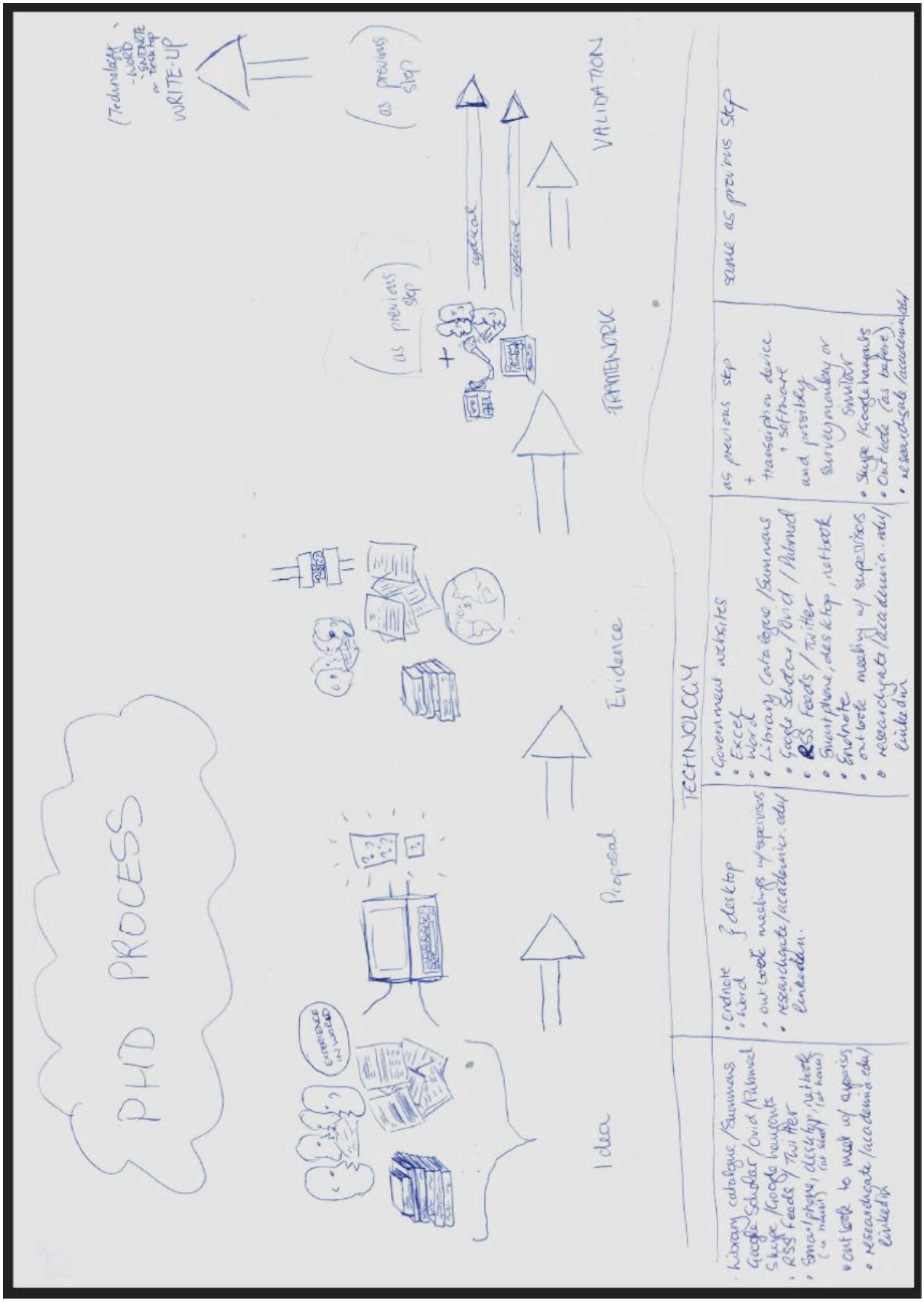
Participant-1: Charles's Modified Drawing



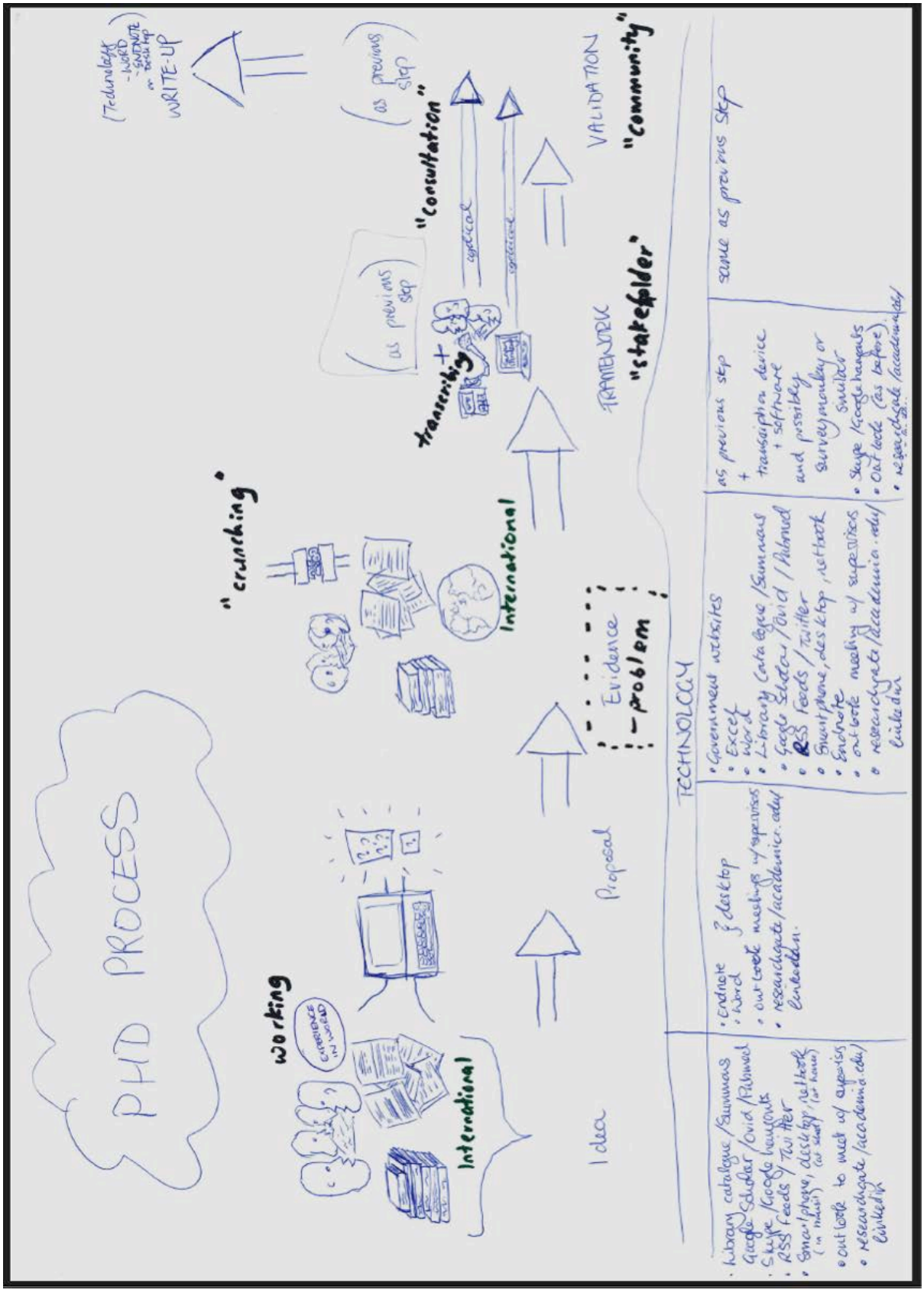
Participant-1: Charles's Modified Stimulus Diagram



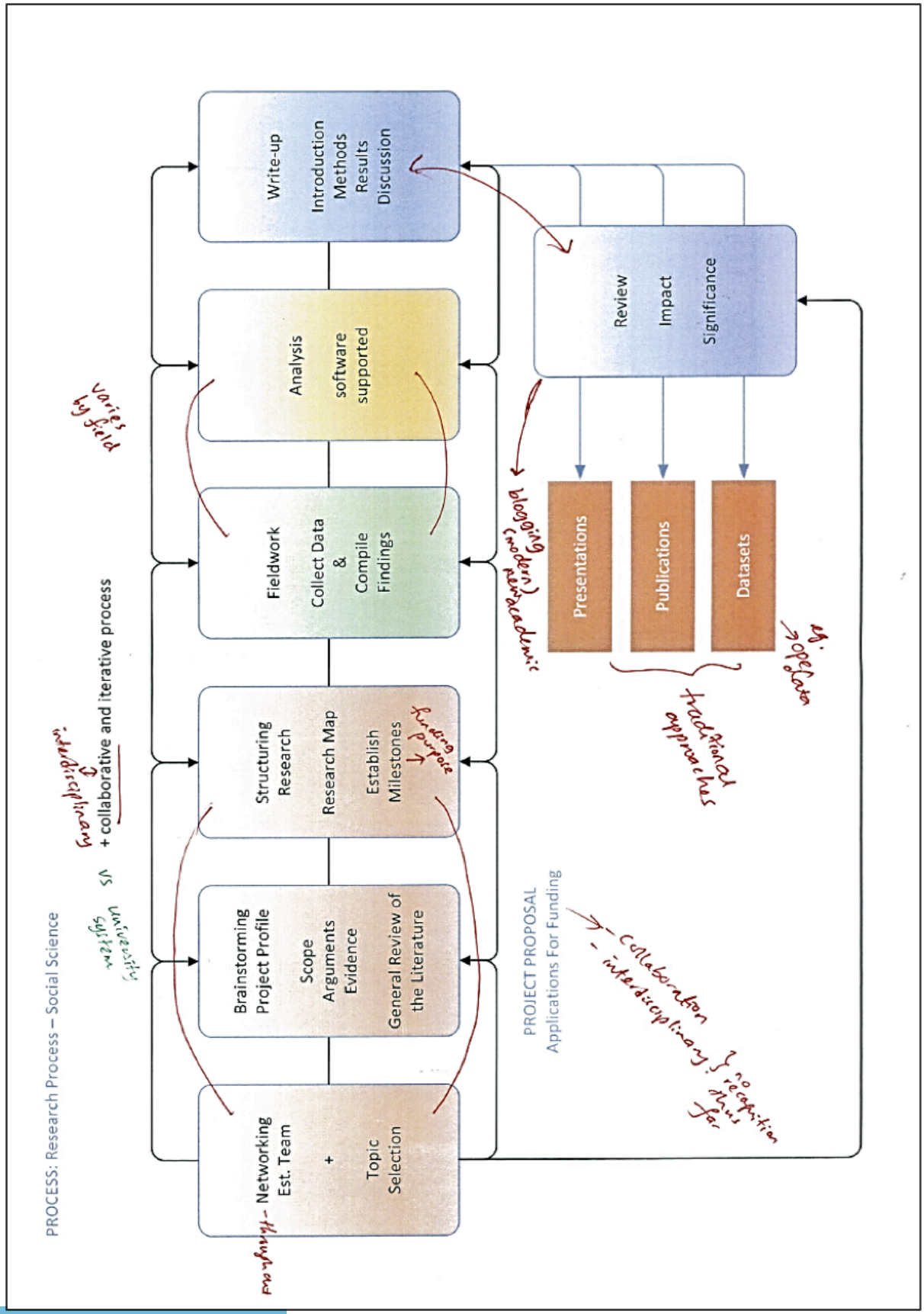
Participant-2: Elizabeth's Drawing



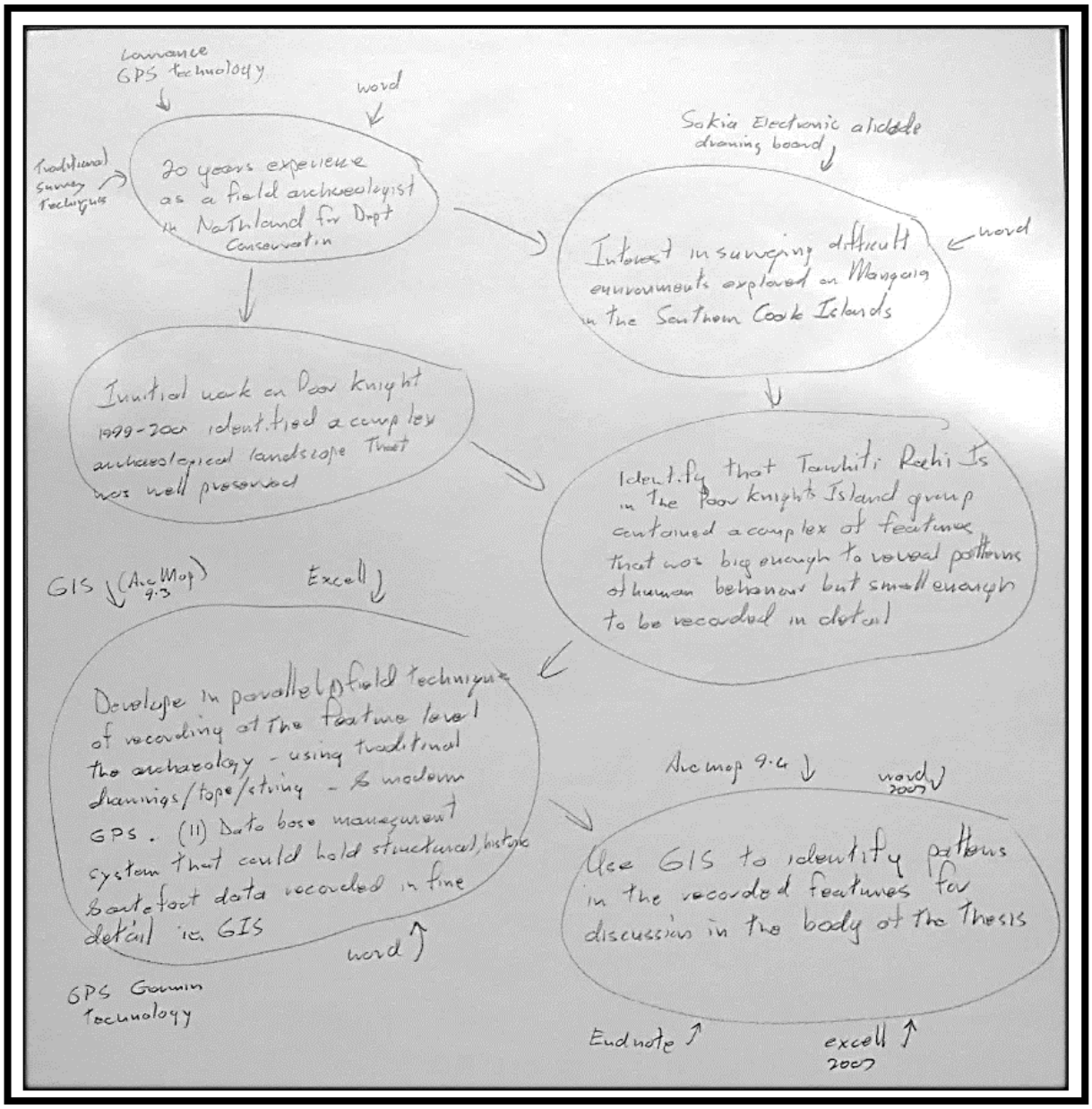
Participant-2: Elizabeth's Modified Drawing



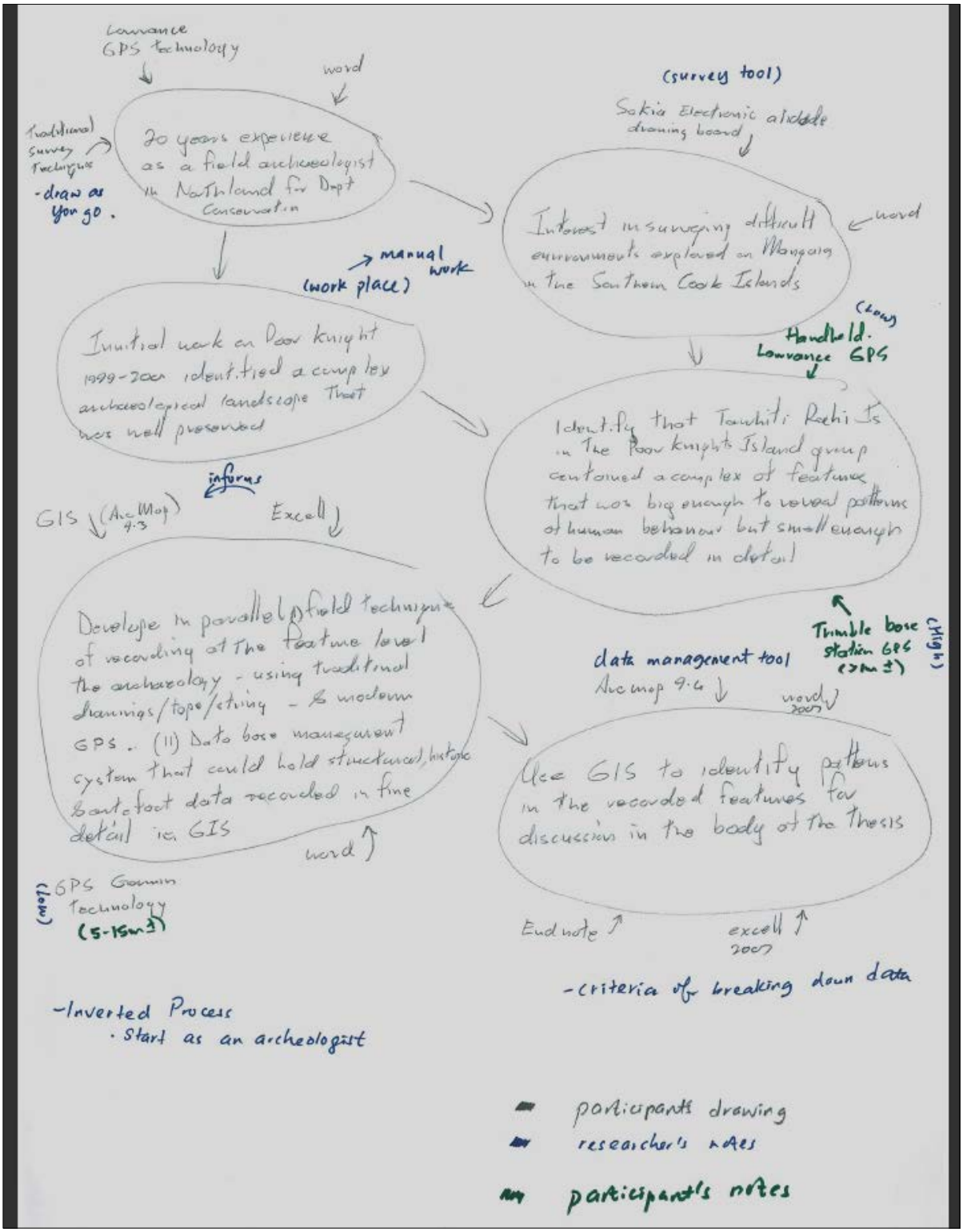
Participant-2: Elizabeth's Modified Stimulus Diagram



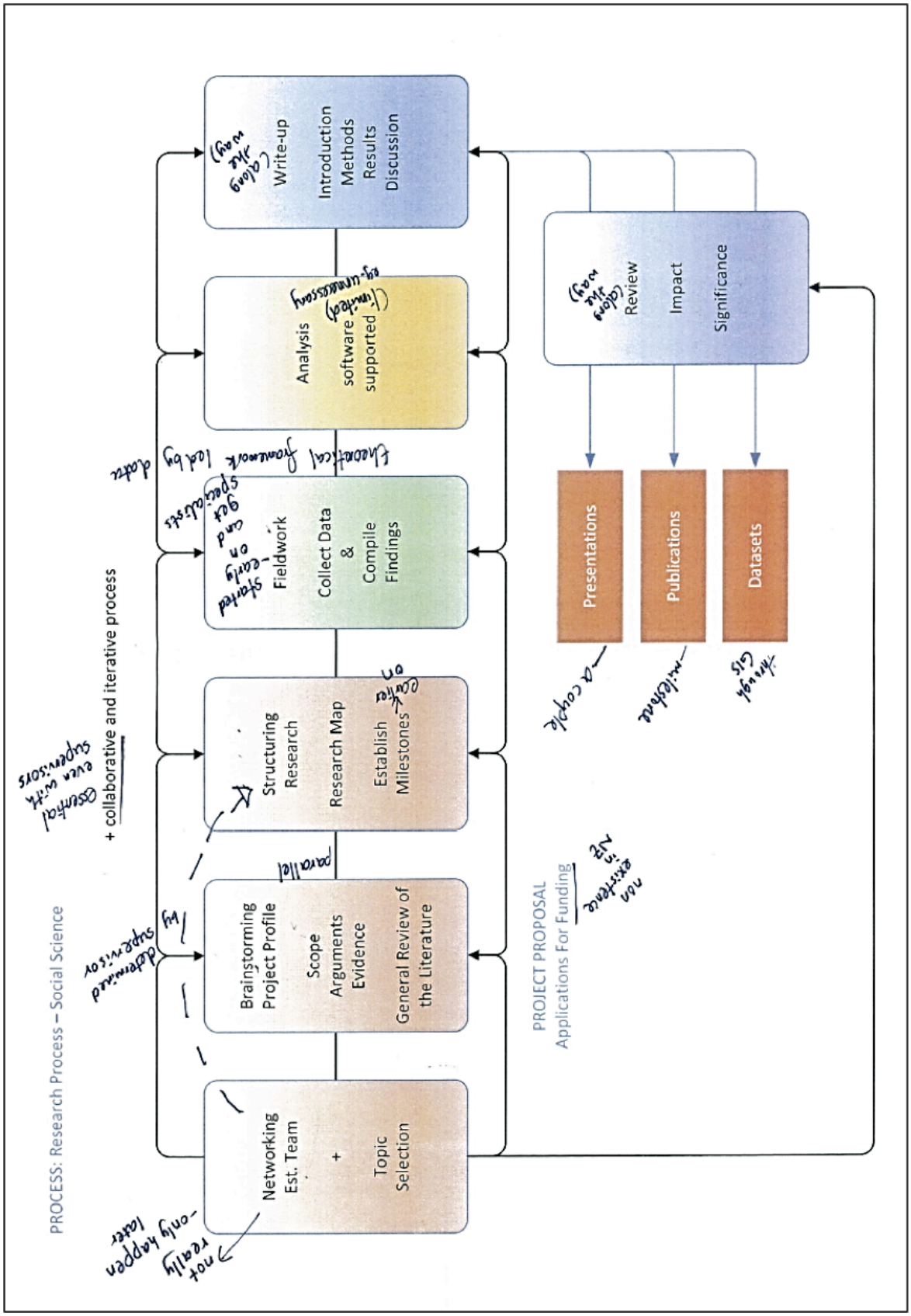
Participant-3: Jeremy's Drawing



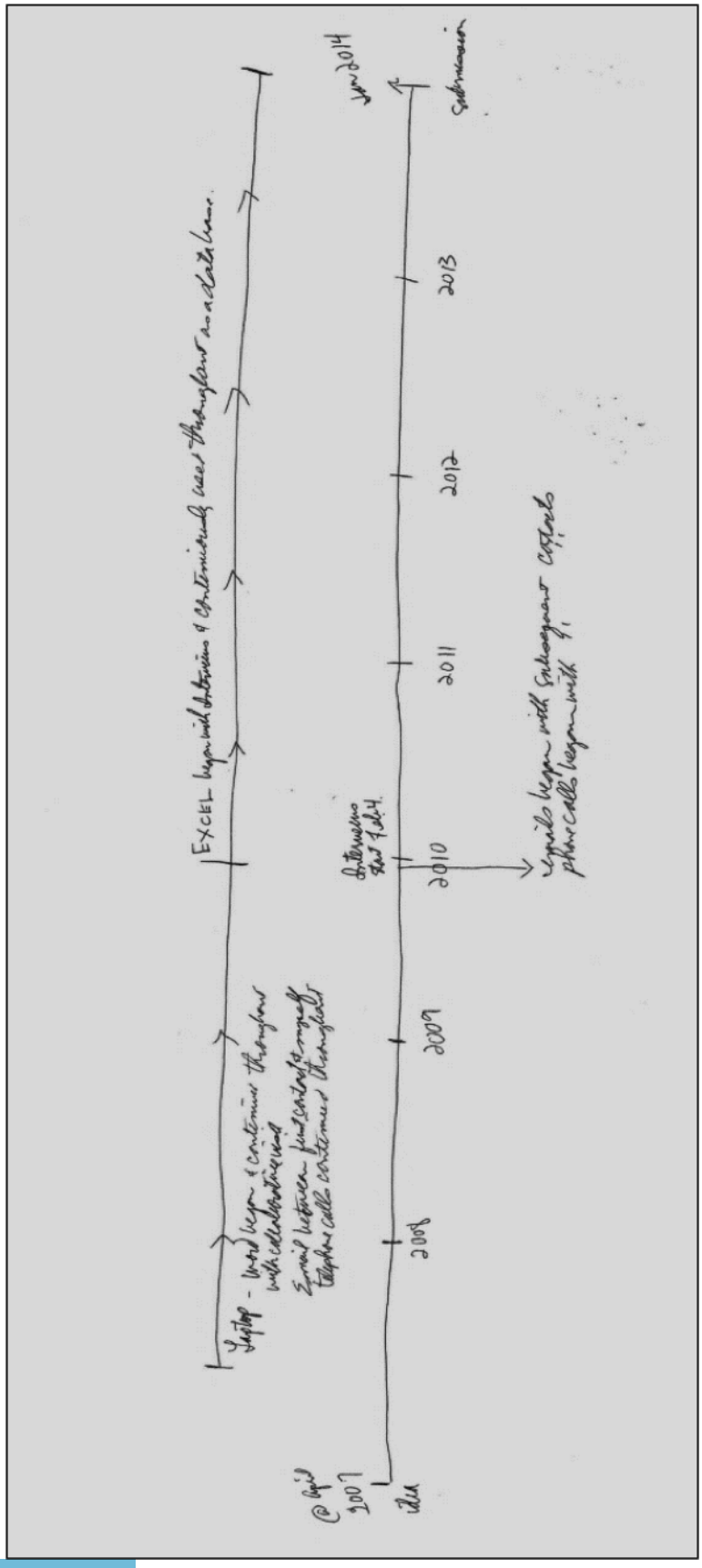
Participant-3: Jeremy's Modified Drawing



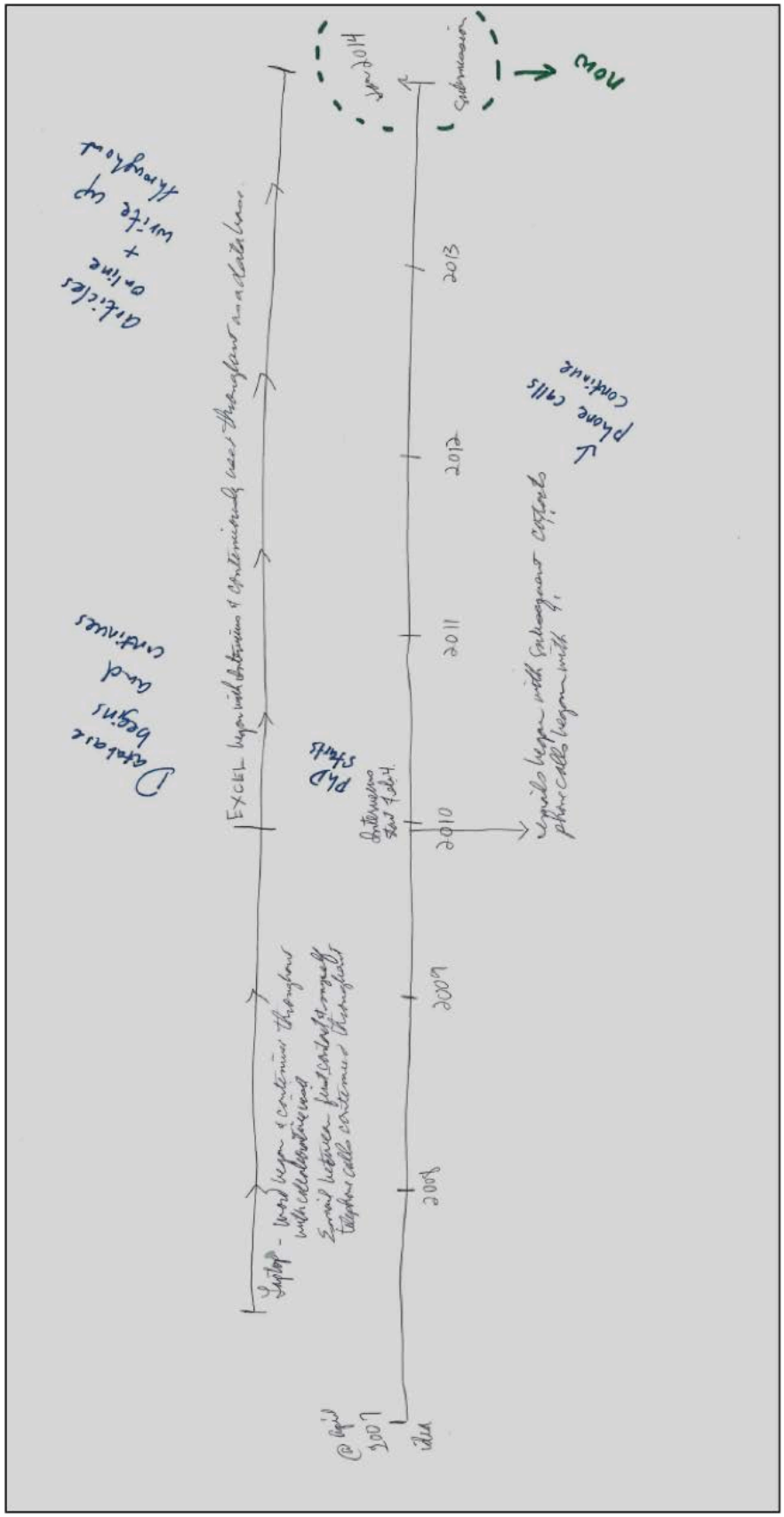
Participant-3: Jeremy's Modified Stimulus Diagram



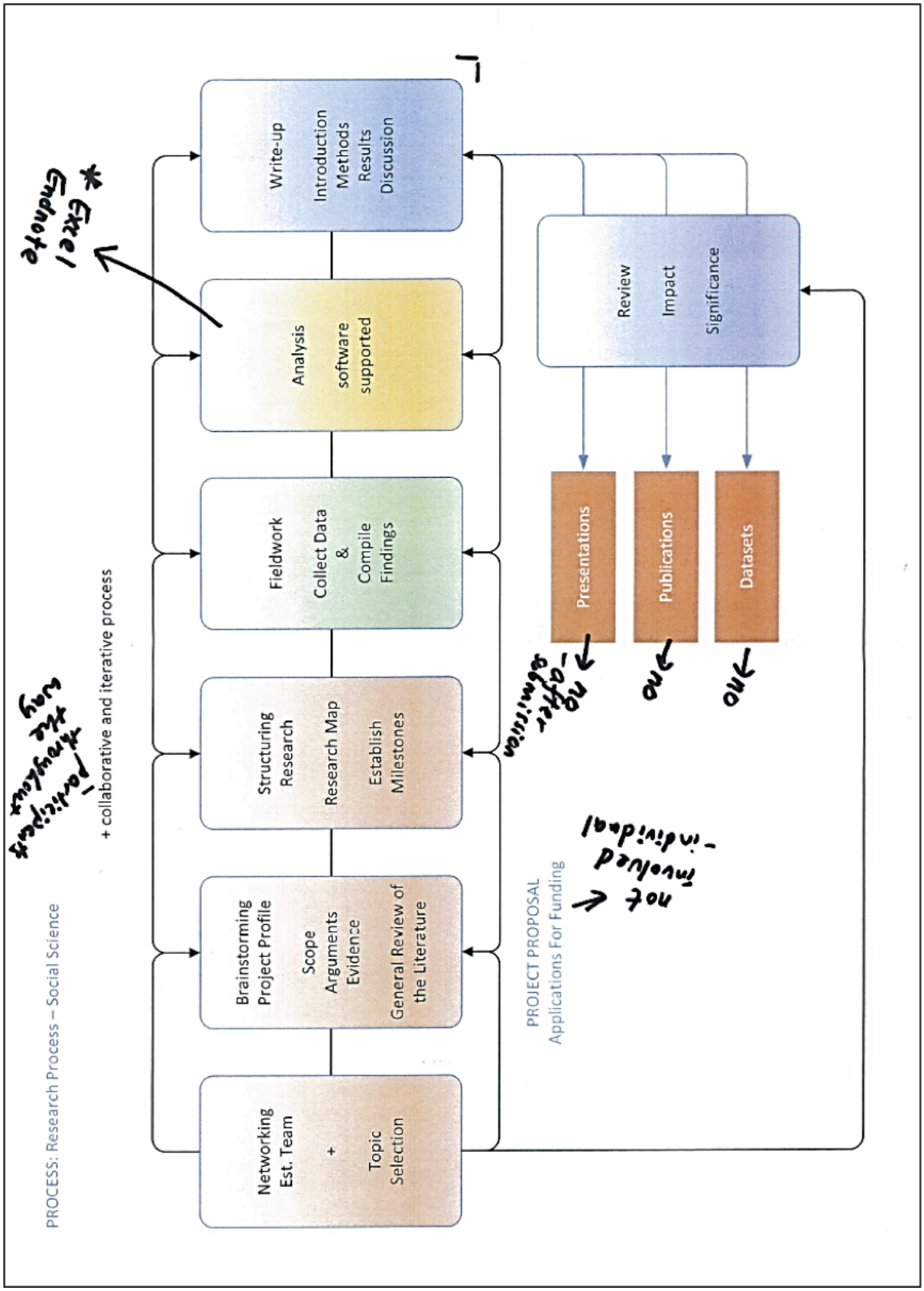
Participant-4: Mandy's Drawing



Participant-4: Mandy's Modified Drawing

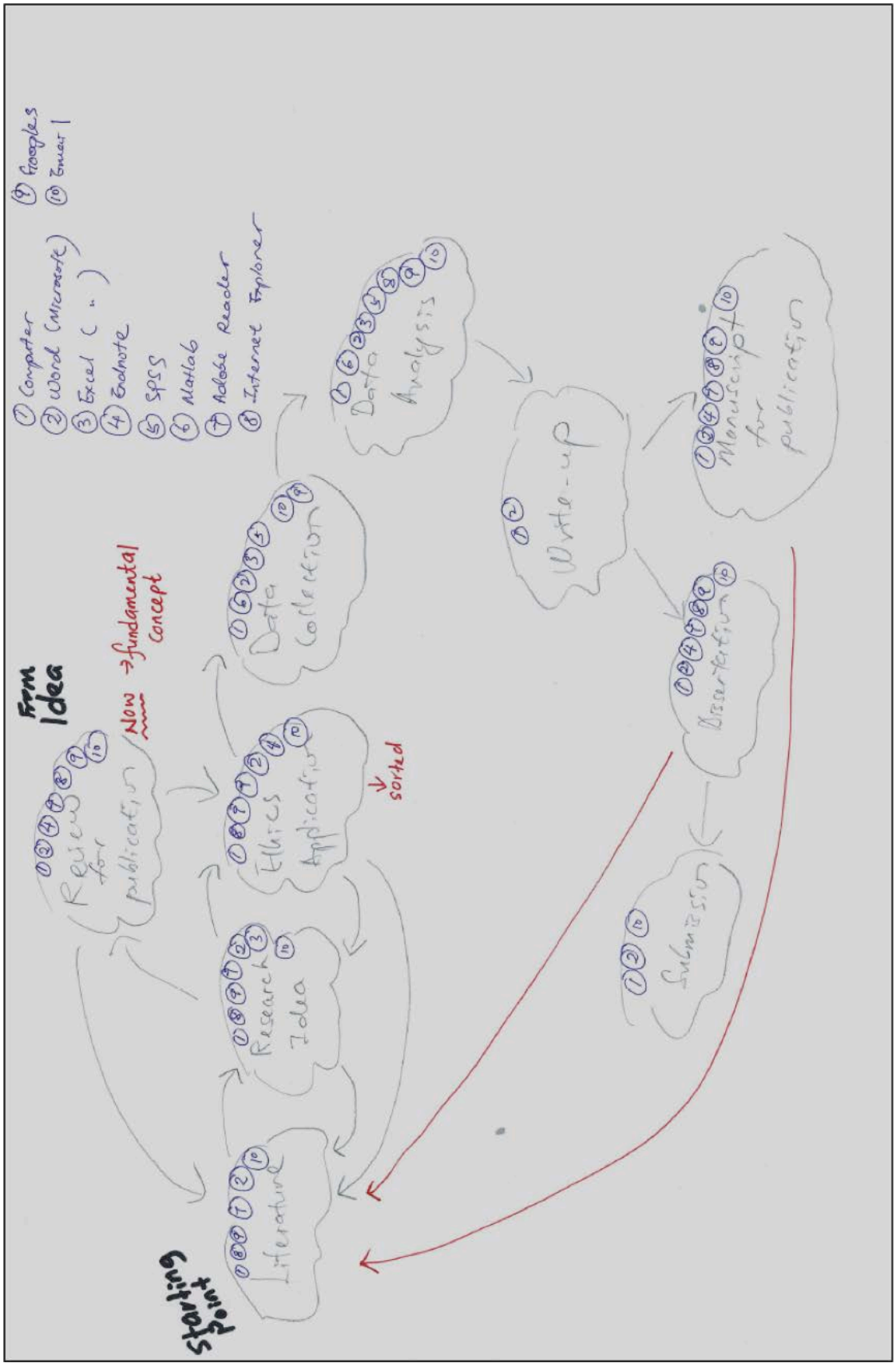


Participant-4: Mandy's Modified Stimulus Diagram

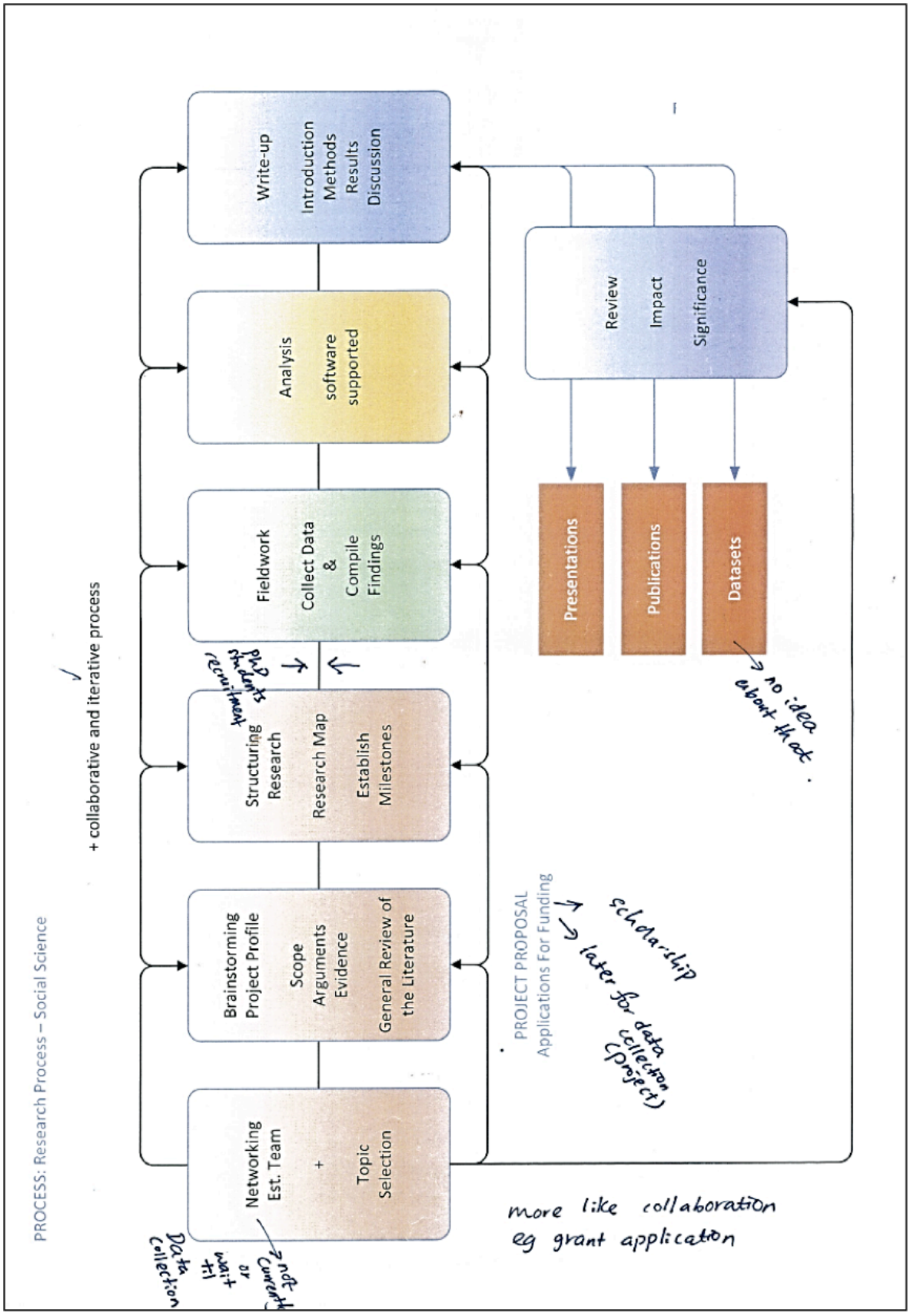


Participant-5: Patricia's Drawing

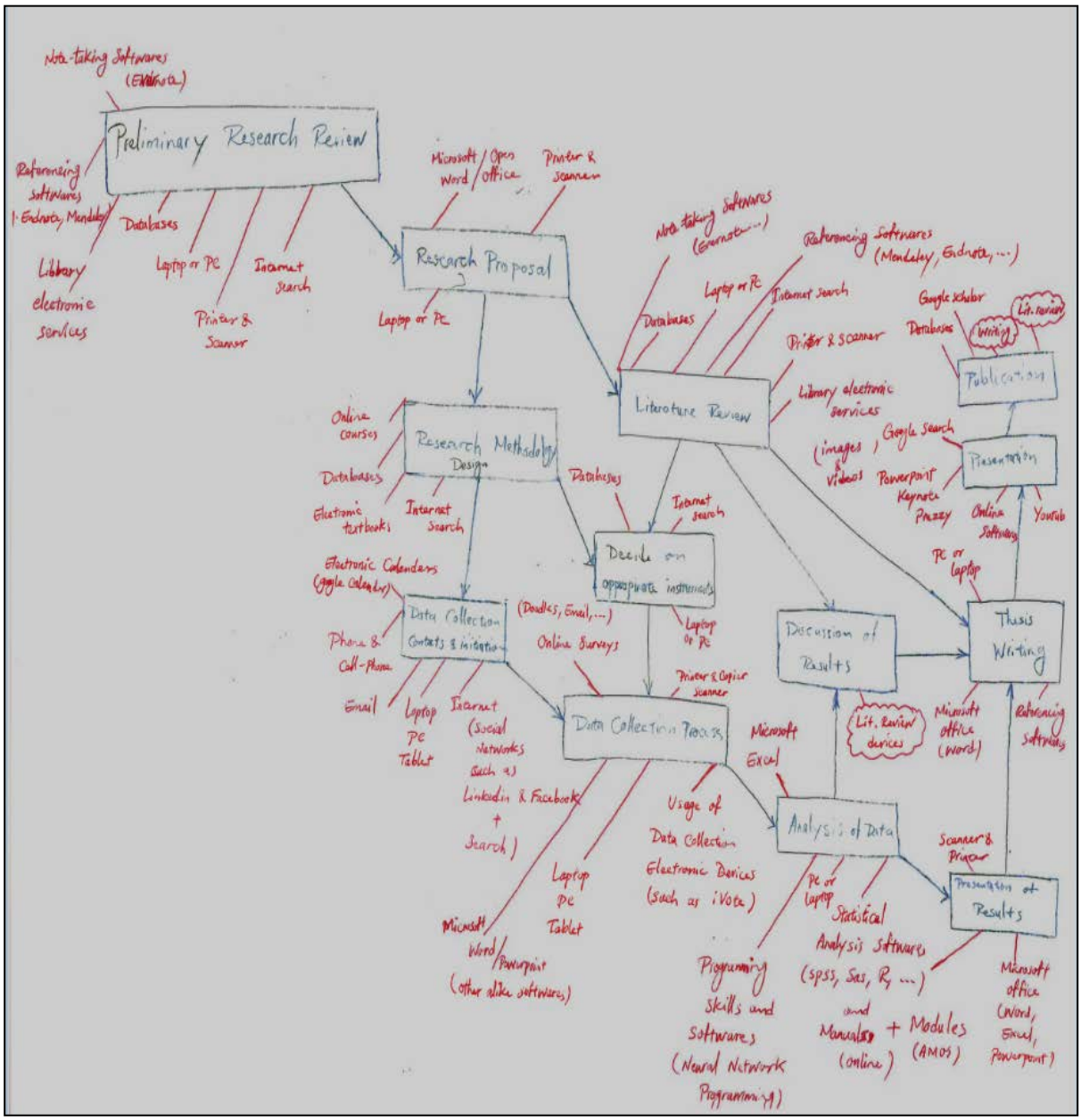
Participant-5: Patricia's Modified Drawing



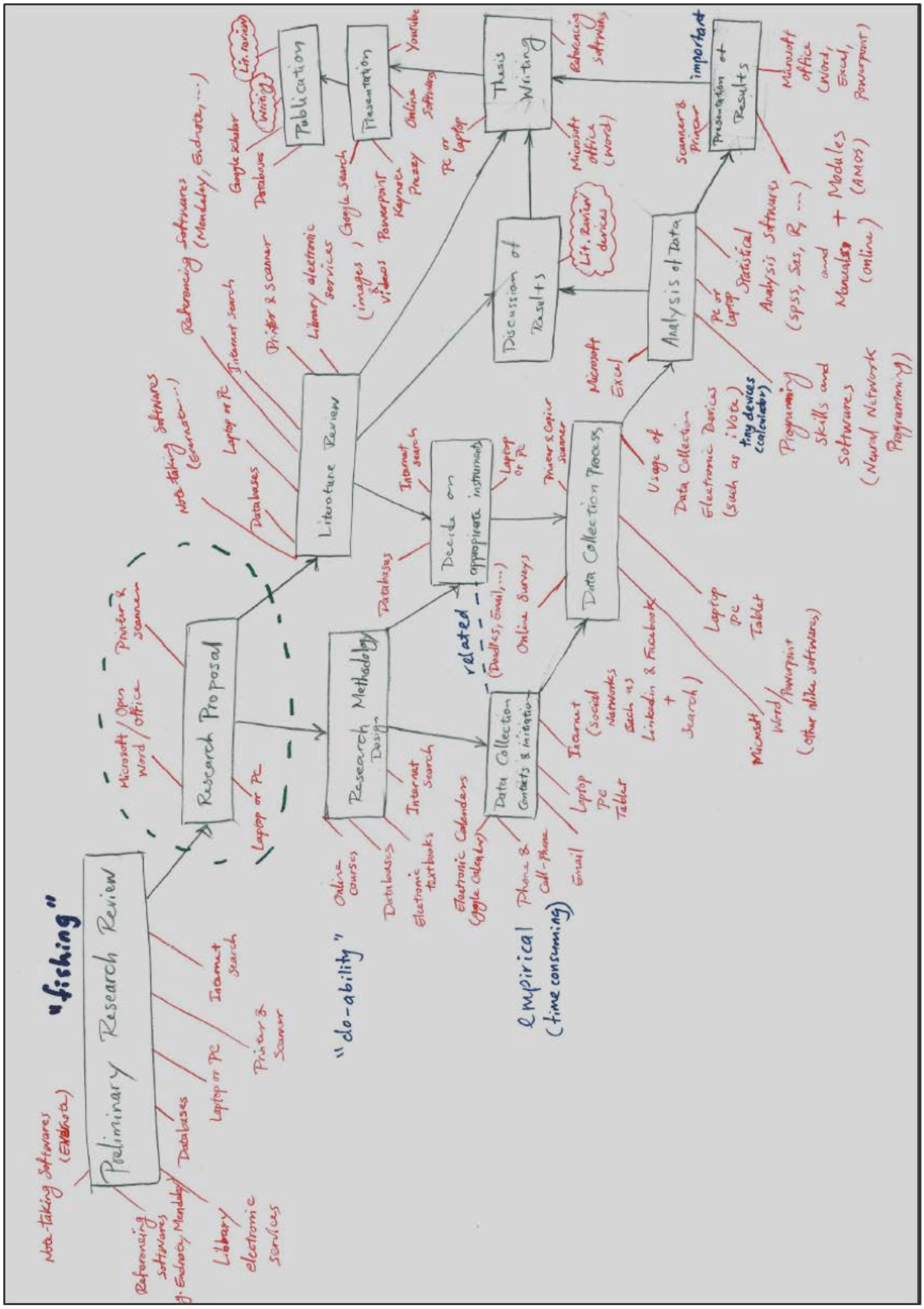
Participant-5: Patricia's Modified Stimulus Diagram



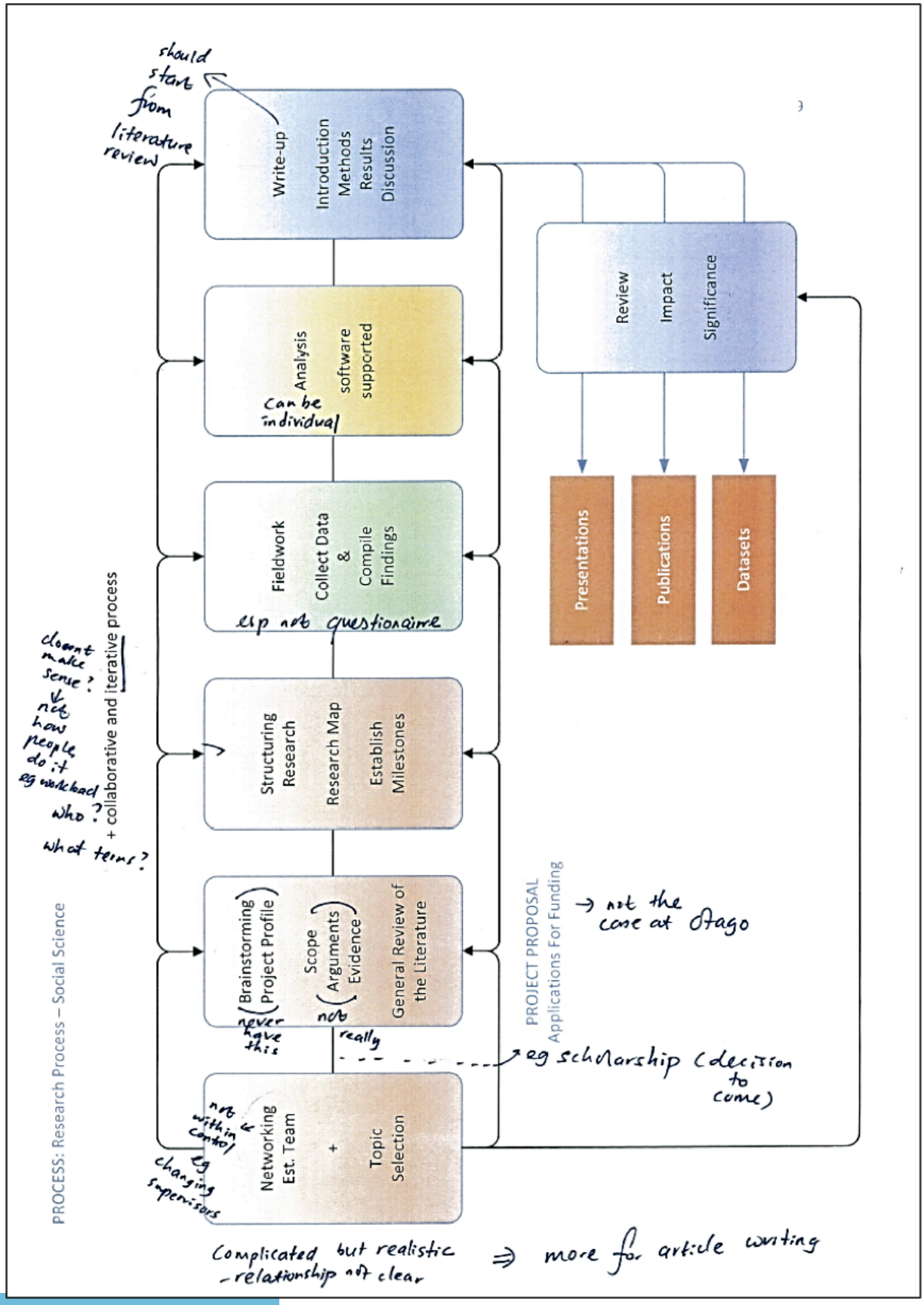
Participant-6: Sam's Drawing



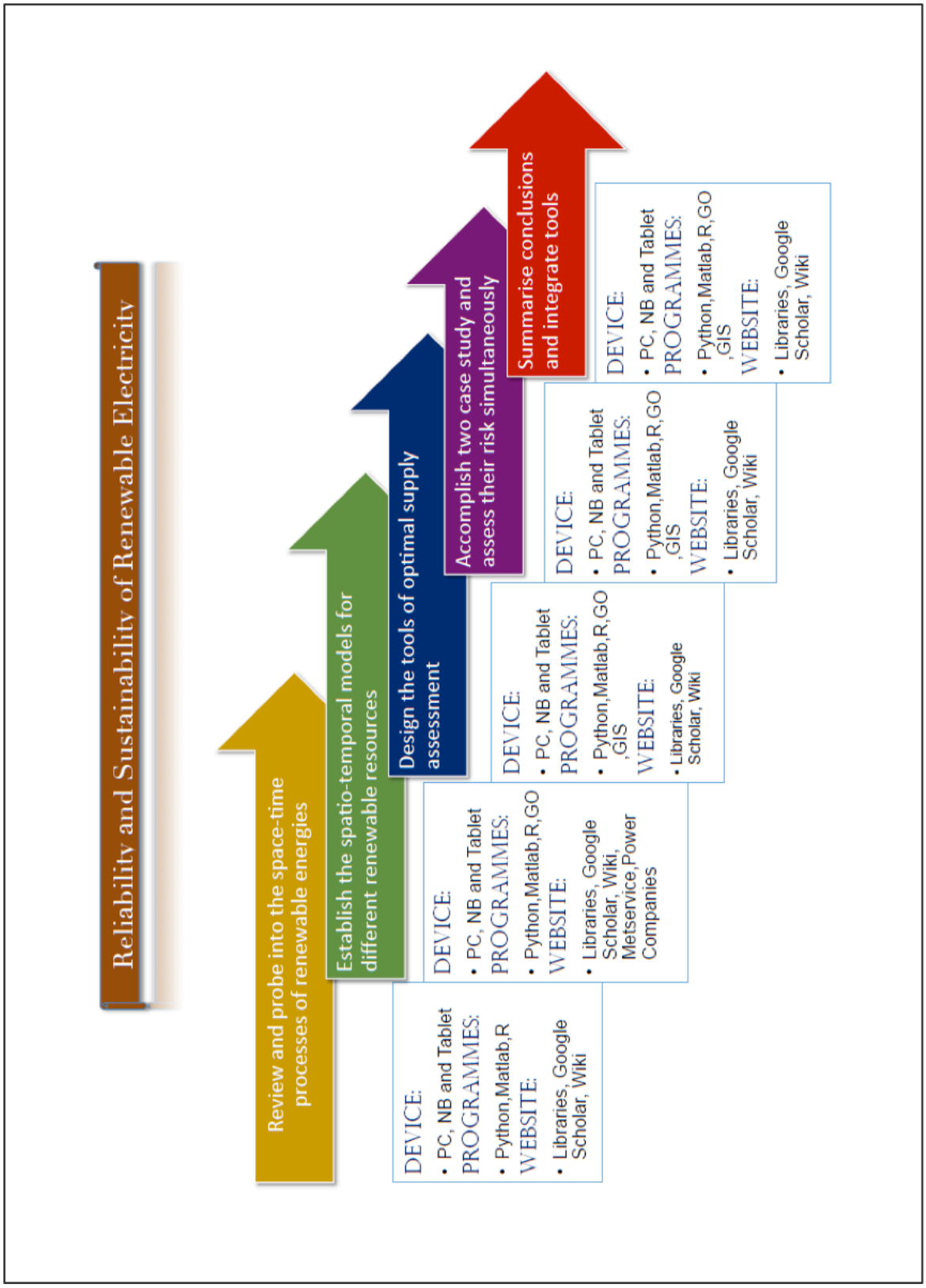
Participant-6: Sam's Modified Diagram



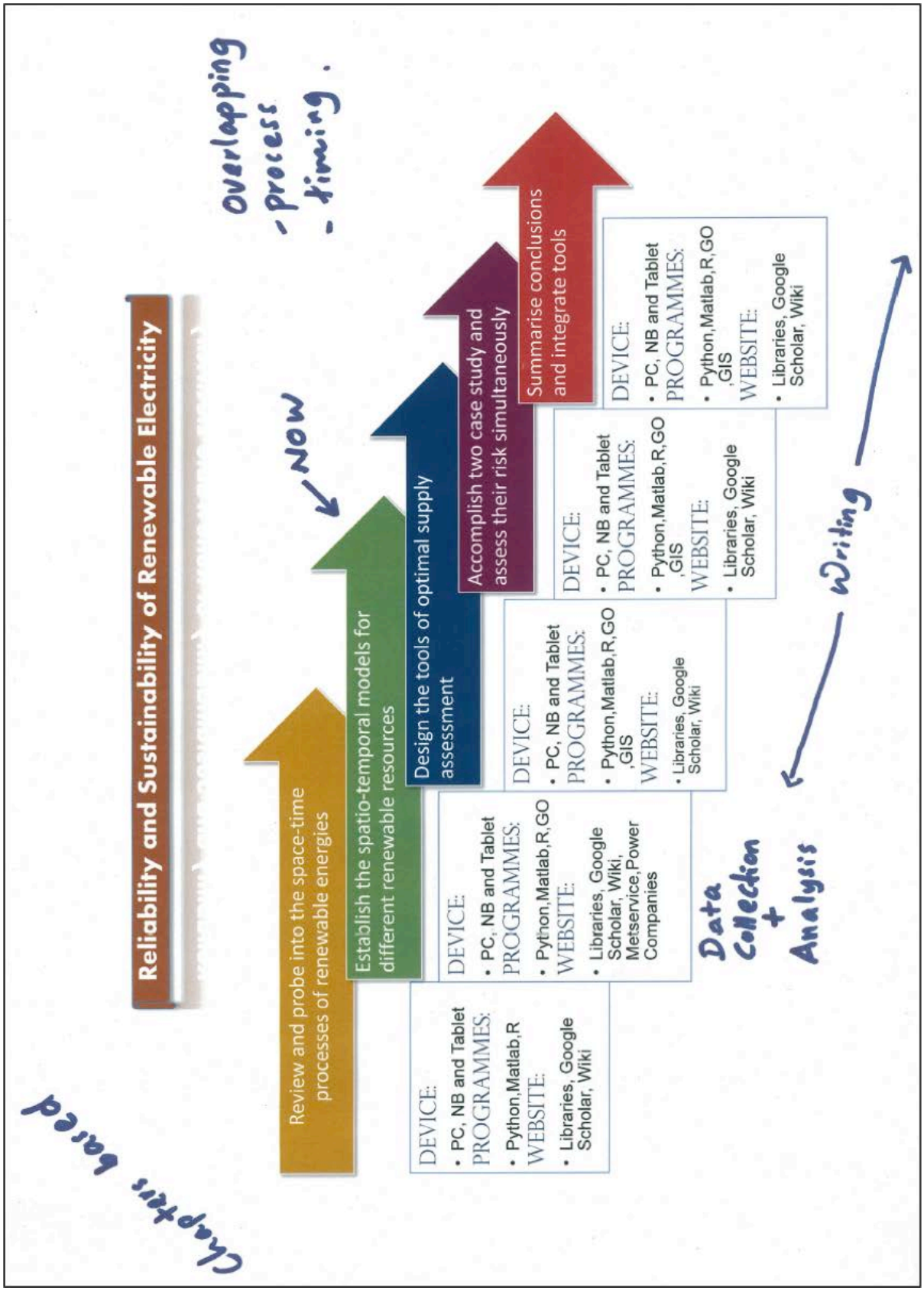
Participant-6: Sam's Modified Stimulus Diagram



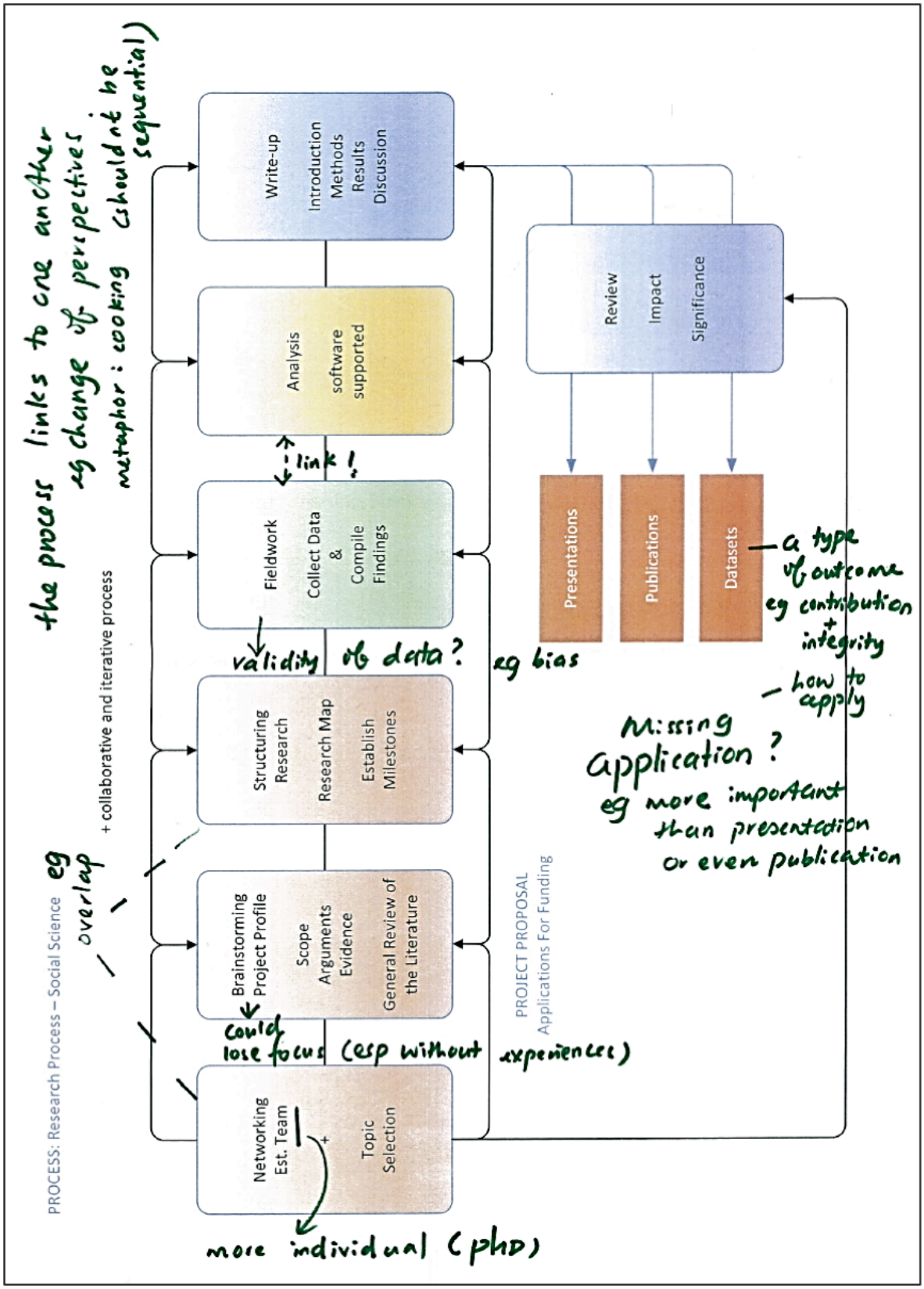
Participant-7: Shaun's Diagram



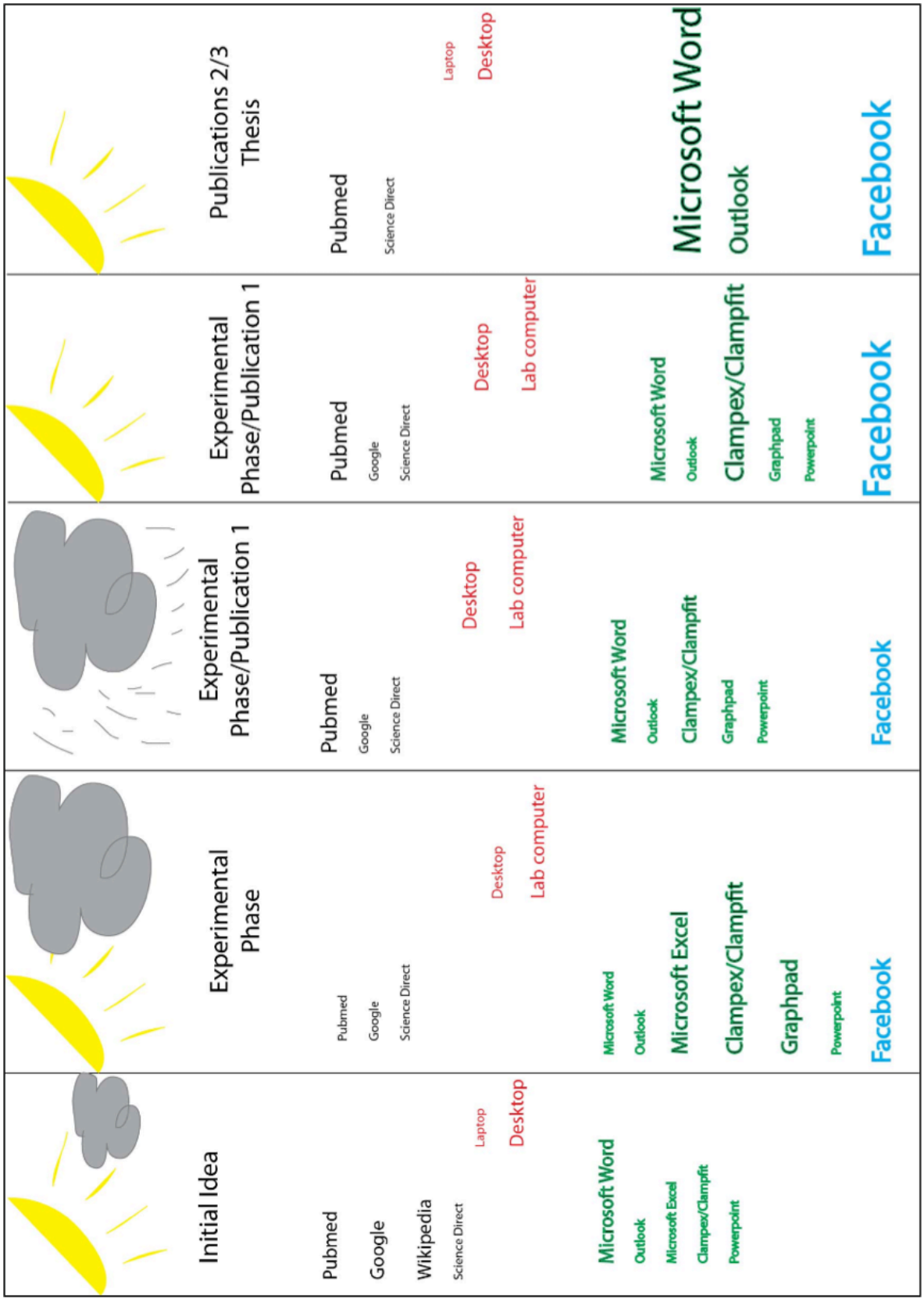
Participant-7: Shaun's Modified Diagram



Participant-7: Shaun's Modified Stimulus Diagram

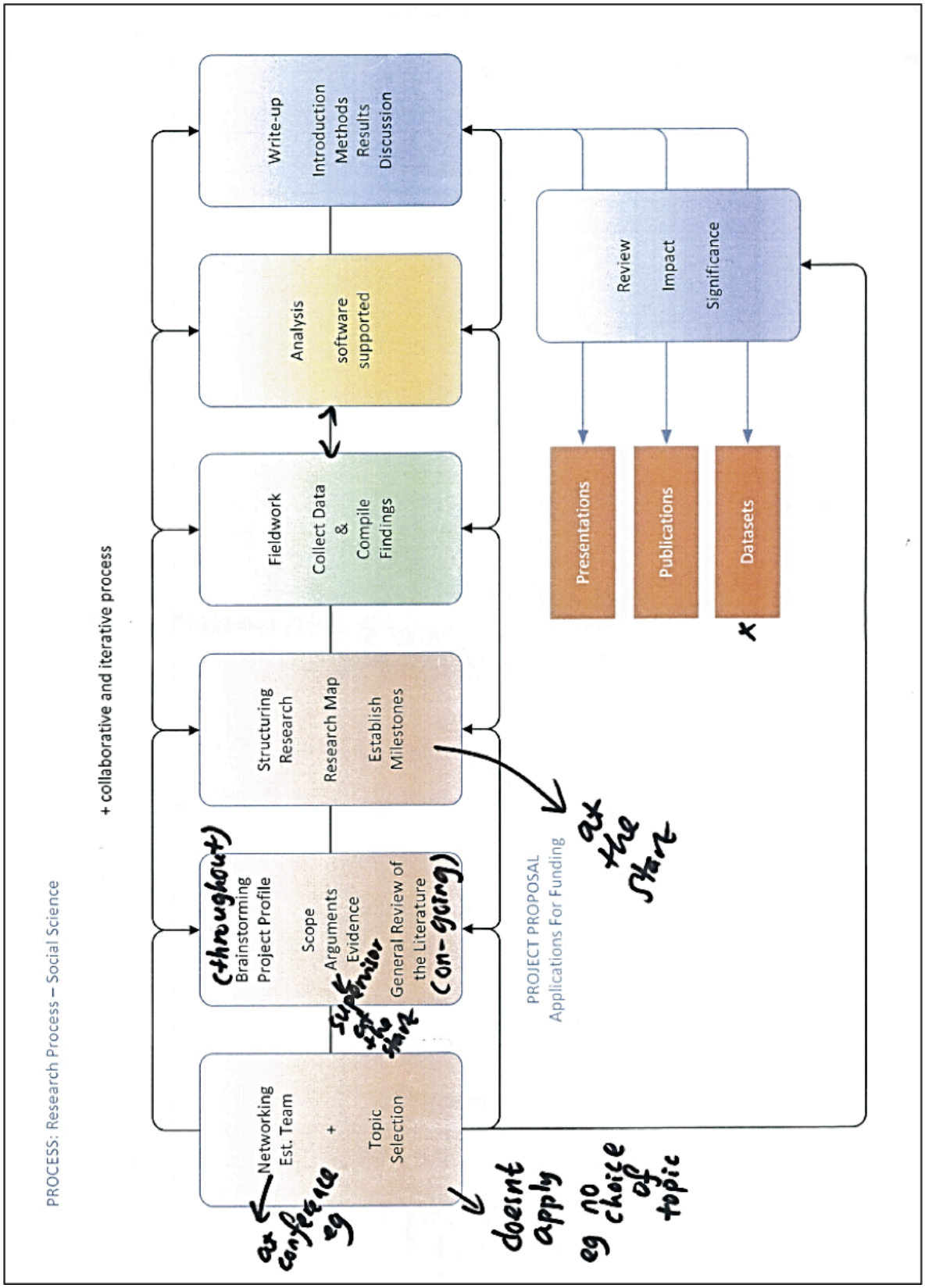


Participant-8: Steve's Diagram

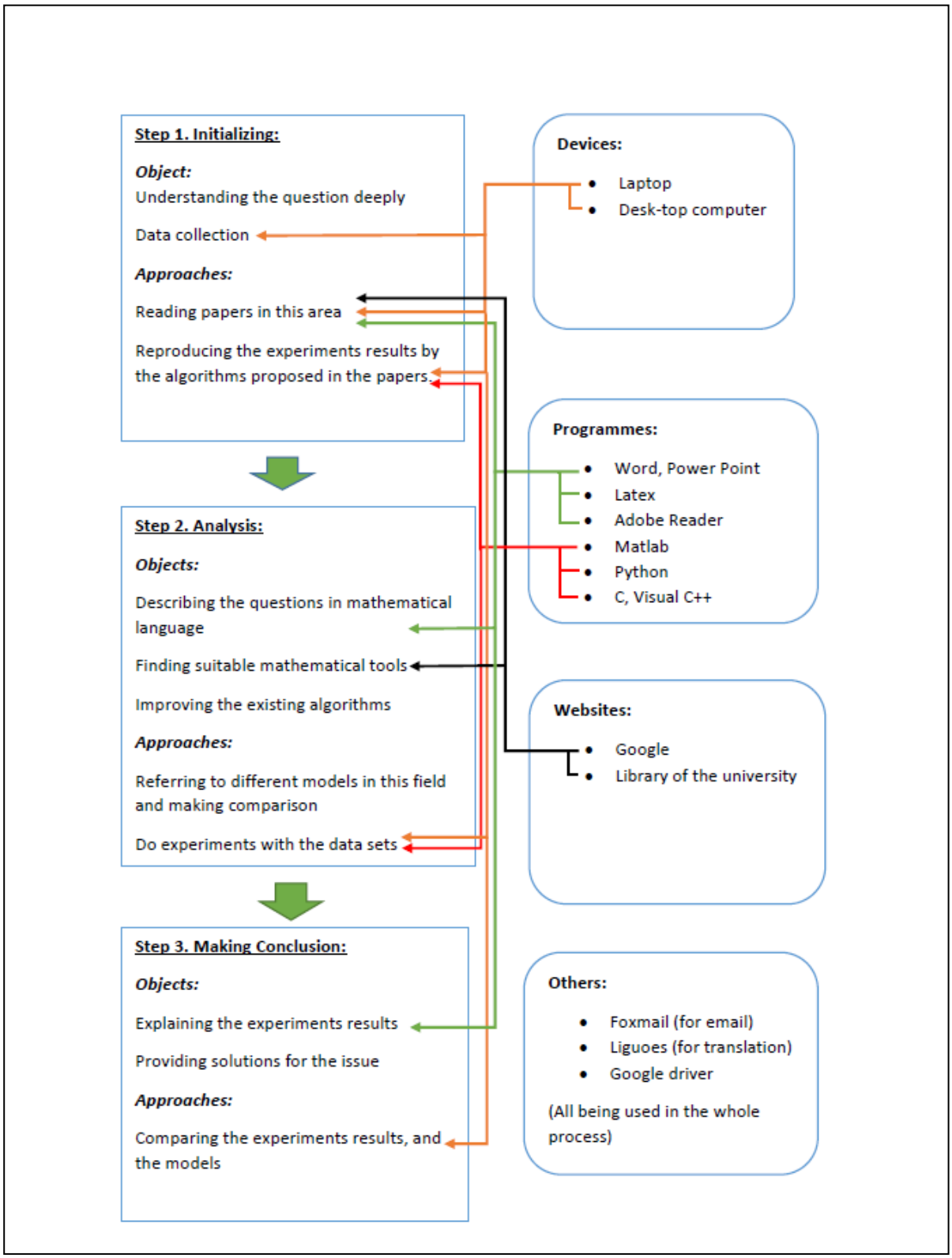


Participant-8: Steve's Modified Diagram

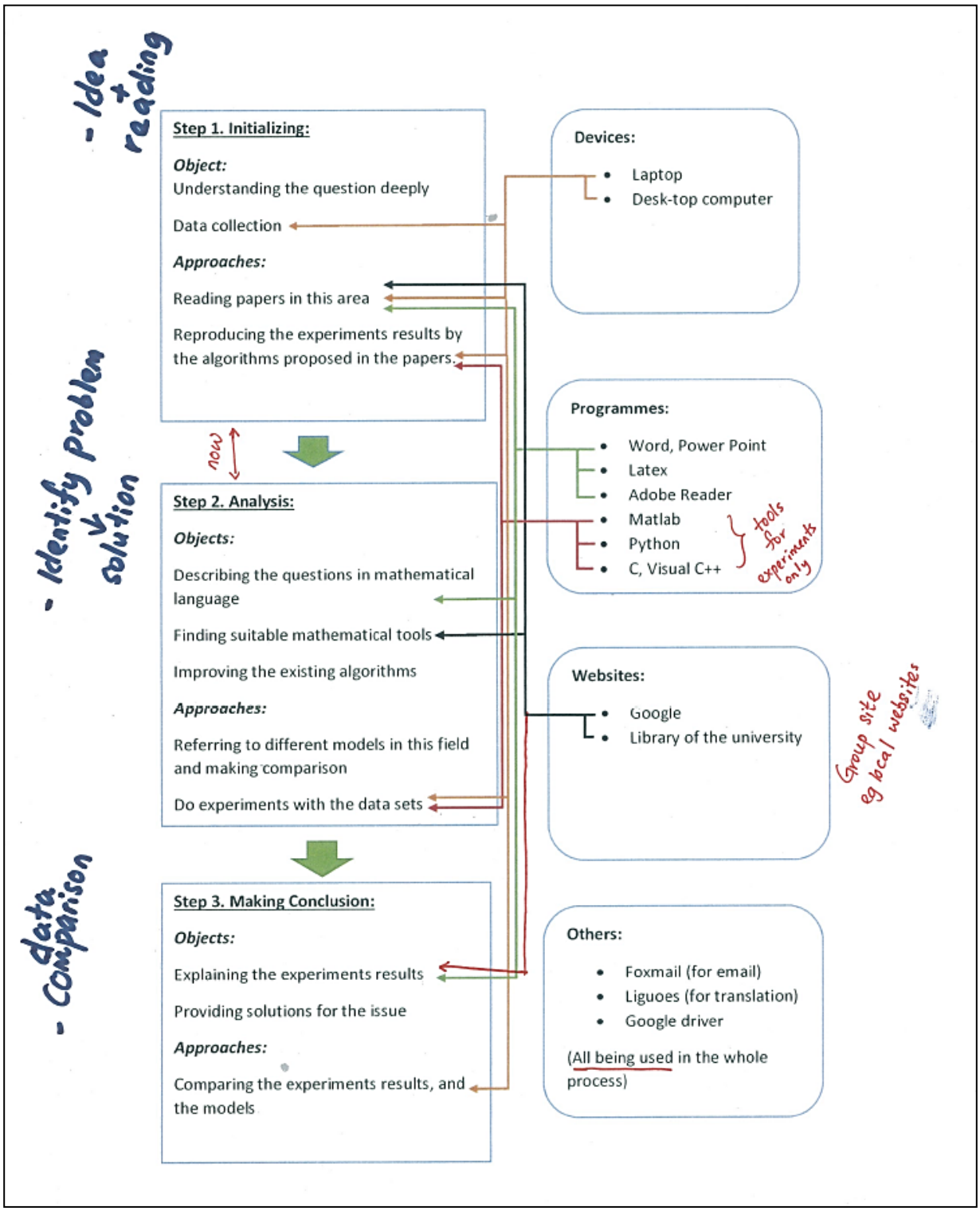
Participant-8: Steve's Modified Stimulus Diagram



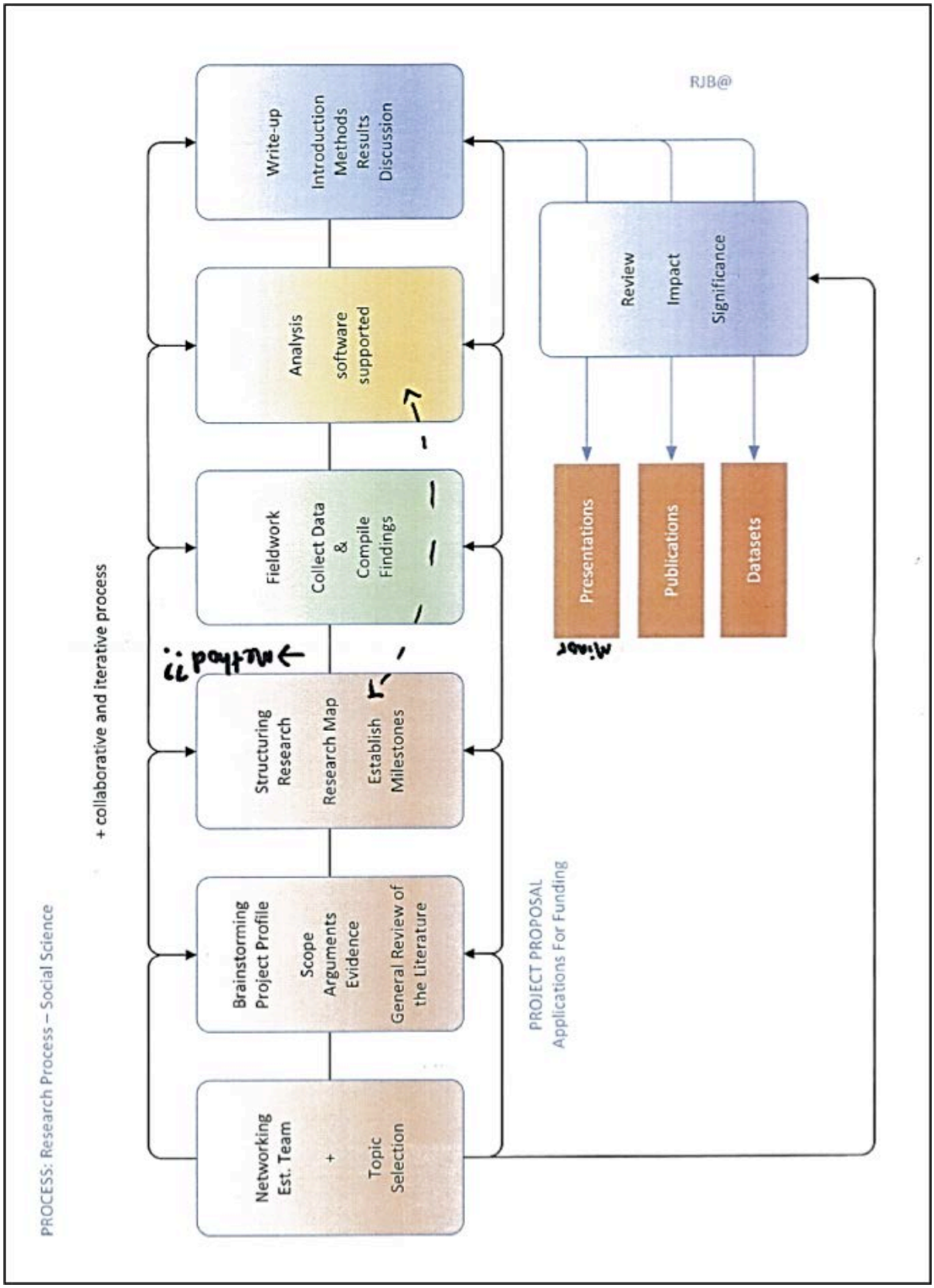
Participant-9: Xavier's Diagram



Participant-9: Xavier's Modified Diagram



Participant-9: Xavier's Modified Stimulus Diagram



Appendix 4: Ethics Consideration

Approval Letter

13/219

Academic Services
Manager, Academic Committees, Mr Gary Witte

29 October 2013

Dr S Stein
Higher Education Development Centre

Dear Dr Stein,

I am again writing to you concerning your proposal entitled "**An investigation into the way PhD students utilise ICT to support their research process**", Ethics Committee reference number **13/219**.

Thank you for the email from KwongNui Sim requesting an amendment to allow for the use of filming and taking photographs of participants during discussions with them. This will allow the students to demonstrate exactly how they use ICT. Thank you for providing a clear outline of the consequential amendments that will be made to the Information Sheet and Consent Form; and noting issues relating to data security, data storage, and maintaining anonymity. The Committee notes that the researcher will discuss the filming with participants at each session.

We commend you on the high standard of this request for amendment.

Your proposal continues to be fully approved by the Human Ethics Committee. If the nature, consent, location, procedures or personnel of your approved application change, please advise me in writing. I hope all goes well for you with your upcoming research.

Yours sincerely,

Mr Gary Witte
Manager, Academic Committees
Tel: 479 8256
Email: gary.witte@otago.ac.nz

c.c. Assoc. Prof. A D Harland Head Higher Education Development Centre

HUMAN ETHICS APPLICATION: CATEGORY A

1. **University of Otago staff member responsible for project:**
   Stein, Sarah (Dr – Senior Lecturer)

2. **Department:** Higher Education Development Centre

3. **Contact details of staff member responsible:** sarah.stein@otago.ac.nz

4. **Title of project:** An investigation into the way PhD students utilise ICT to support their research process

5. **Indicate type of project and names of other investigators and students**:

Staff Research	☐	**Names**	
Student Research	■	**Names**	KwongNui Sim
Level of Study (e.g. PhD, Masters, Hons)			PhD
External Research/ Collaboration	☐	**Names**	
Institute/Company			

6. **Is this a repeated class teaching activity?**

   YES / NO

   If YES, and this application is to continue a previously approved repeated class teaching activity, please provide Reference Number:

7. Fast-Track procedure

Do you request fast-track consideration? *(See 'Filling Out Your Human Ethics Application')*

YES / NO

If YES, please state specific reasons:-

8. When will recruitment and data collection commence?

September 2013

When will data collection be completed?

March/April 2014

9. Funding of project.

Is the project to be funded by an external grant?

YES / NO

If YES, please specify who is funding the project:

If commercial use will be made of the data, will potential participants be made aware of this before they agree to participate? If not, please explain: **No commercial use will be made of the data**

10. Brief description in lay terms of the purpose of the project (approx. 75 words)**:**

Research has indicated that Information and Communication Technologies (ICT) are a necessary part of academic practice in higher education (e.g., Aspden & Thorpe, 2009). Under normal circumstances, PhD students have to use ICT throughout their research journey, yet little attention being given to how they use ICT to support their research practice. This project aims to address this lack of knowledge in the literature by investigating University of Otago PhD students' use of ICT and their related assumptions and expectations.

11. Aim of project, including the research questions the project is intended to answer:

The focus will be on the context(s) in which the PhD students utilise ICT to support their research process. While ICT has become increasingly commonplace in higher education, especially in academic research practice, it is therefore valuable to determine the significance of ICT in PhD students' research journey.

The overall aim of the project is to investigate the beliefs and practices related to ICT and research processes held by students as they undertake their PhD study.

The following specific objectives will contribute to achieving the overall aim of the project:

1. To elicit the assumptions and expectations of ICT utilisation to support research processes held by PhD students at different stages of their study and from different disciplines.

2. To examine the degree to which ICT are utilised by PhD students in their research processes through an examination of their practice.

3. To compare the stated assumptions and expectations (from specific objective 1) and practices (from specific objective 2) with existing research studies reporting the role of ICT to support study.

4. To draw conclusions about the nature of ICT use among PhD students and to provide insights and implications for postgraduate supervision and research practice that will benefit institutions, disciplines, supervisors, and students.

The investigation will be framed around the following questions:

1. To what extent do PhD students use ICT to support their research process?

2. Do/how do the assumptions and expectations of ICT held by PhD students influence their ICT practice; and do/how do PhD students' ICT practices inform their perspectives on ICT use?

3. What is the relationship between the ICT assumptions, expectations, actual practice of PhD students and related claims concerning the role of ICT documented in the research literature?

4. How is the nature of ICT use among PhD students established from this study beneficial for different communities (the institution, the disciplines, the lecturers, the supervisors, and the students)?

The answers to these questions require knowledge of the way in which PhD students actually use, experience, and integrate ICT throughout their research process in conjunction with the assumptions and expectations of the role of ICT from various perspectives (e.g. literature, institutions, disciplines, lecturers/supervisors, and students).

12. Researcher or instructor experience and qualifications in this research area:

The student researcher:

The student researcher has 8 years of teaching and tutoring experience (2001 – 2008) in investigating learning and teaching while she was in Malaysia. The tutoring role continues now she is in New Zealand (2009, 2011, and 2013). After she had completed her undergraduate and postgraduate diploma studies at the University of Otago, she pursued her Masters study in Higher Education. Her Masters research was in a similar area as the research outlined in the ethics application, but was a smaller project that focused on undergraduate use of ICTs. While doing her Masters research, she completed a University of Otago Summer Scholarship Project for 2011/2012. So far, she has presented her Masters research at the following sessions:

1. Butson, R., & Sim, KN. (2012). The Role/Importance of Personal Computers in Undergraduate Study. Higher Education Development Centre Research, Seminar Series. University of Otago.

2. Sim, KN. (2012). The Power of Personal Computers. Postgraduate Research Conference on Power and Politics 2012. University of Otago.

3. Sim, KN. (2012). The Role/Importance of Personal Computers to Support Learning in Higher Education. HEDC Postgraduate Research Day. University of Otago.

4. Sim, KN., & Butson, R. (2013). Do Undergraduates Use Their Personal Computers to Support Learning? International Educational Technology Conference. Kuala Lumpur, Malaysia.

5. Sim, KN., Stein, S. & Butson, R. (2013). The Role/Importance of Personal Computers to Support Learning in Higher Education. The European Conference on Technology in the Classroom. Brighton, UK.

Recently, her refereed journal article with Russell Butson on "To what degree do personal computers play a role in undergraduate study?" was accepted by *Journal of Computer Assisted Learning* and her conference proceeding with Russell Butson on "Do undergraduates use their personal computers to support learning?" was published online by the 13th International Educational Technology Conference IETC-2013. She is now preparing to submit a full paper on "The Role/Importance of Personal Computers to Support Learning in Higher Education" to 2013 The European Conference on Technology in the Classroom for IAFOR Journal of Education publication.

Since 2012, she has undertaken research assistant work for experienced researchers at Higher Education Development Centre, University of Otago outlined as below:

1. Associate Professor Tony Harland (September to December 2012)
- assisted with data collection on the topic "Assessment System at the University of Otago"

- assigned to do a summary writing on the topic "Assessment Practice at the University of Otago: From a Historical Perspective"

2. Dr Sarah Stein – May and June 2013
- assisted with the analysis of interview and survey data based on a provided framework on the topic "An analysis of discourses: Staff Development through Evaluation System"

3. Associate Professor Tony Harland – August to December 2013
- assisted with collecting and comparing policies of the assessment/grading systems among the universities (New Zealand, Australia, US, UK, Canada, and Europe)

- assigned to contribute towards the model of 'best practice' for assessment/grading system at the University of Otago

The supervisors:

The supervisors have extensive experience researching professional development, teaching and learning in tertiary institutions.

13. Participants

13(a) Population from which participants are drawn:

PhD students at different levels (1st, 2nd, and 3rd years) in four disciplines (Health Science, Sciences, Commerce, and Humanities) at the University of Otago

13(b) Specify inclusion and exclusion criteria:

Inclusion:

- Regardless domestic or international PhD students
- ideally, there will be a balanced distribution of gender, disciplines, and levels of study among the twelve students
- Window users (due to the nature of the data capturing software); and
- a self-report of being a competent computer user

Exclusion : PhD students who have deferred their degree

13(c) Estimated number of participants:

12 PhD students

13(d) Age range of participants:

No stipulation on age range

13(e) Method of recruitment:

a. Emails of invitation through Graduate Research Services at the University of Otago
b. Personal invitation through Otago Postgraduates Wednesday & Friday Get-together events and Facebook Group Page.

13(f) Please specify any payment or reward to be offered:

No payments or reward will be offered. The participation will be voluntary.

14. Methods and Procedures:

The project investigates the ICT use (experience, attitudes, and strategies) among thirty to sixty PhD students. The proposed data collection methods are outlined as below.

1. *Discussion Group*: Participants will be invited to participate in an informal discussion session, which will be semi-structured in that the researcher will be using general open-ended questions to guide the discussion with the expectation that the participants will take a reasonable degree of control/leadership. The core questions are listed below:

a. What is the role of ICT in your PhD study journey?

b. What are the ICT devices and software you use for your PhD study?

c. How do you integrate ICT into your study?

d. How do you rate your ability to use ICT?

e. Why do you think ICT is important/unimportant to support PhD students in their research process?

This discussion will also serve as an instrument to gather general background information about the participants and their perspectives on how they think they integrate ICT (their selection of technologies, level of competence, and experience

with working with technology) into their research practice. Through this phase the researcher will develop understandings about the participants' expectations and assumptions, as well as practices of the participants in relation to their ICT use. The aim of the process will be to assist the researcher to begin to understand and be able to express each participant's assumptions, expectations and the reasons for behaviours from the perspective of each participant.

Discussions will be audio recorded and fully transcribed. The audio files will be available only to the researcher and her supervisors. The transcriptions will be altered to remove any identifying information prior to use in the preparation of reports, publication and conference papers.

2. *Computer Activity Capture*: Participants will be given free software (ManicTime) that will record the date, time, duration and type of computer programmes used as well as the date, time and duration of the websites visited over a six month period. ManicTime does not record the content of programmes or websites. An orientation session will be offered at the start of the study to inform and train participants in the purpose of using the software. They will have full control of the software, including the ability to turn it on and off and to delete the details it captures. Participants will be made aware that they may withdraw at any time and request that their data be destroyed and excluded from the study. At the completion of the project, participants will be given copies of their data (records of computer activity) and the recording software will be removed from their computers. Participants will have the option to retain software on their computers for their continuing personal use if they so wish.

3. *Participative Drawing*: Participants will be briefed about drawing a mind map, a diagram or any conceptual structure framework based on the themes about ICT use generated from the discussion group. They will undertake the task in their own time, unsupervised by the researcher. They will be given a week to submit their drawing. As with the computer activity data, participants will be made aware that they may withdraw at any time and request that their data be destroyed and excluded from the study.

4. *Individual discussion*: Participants will be invited to attend an individual informal discussion after the preliminary analysis of those two data sources has been completed. The (preliminary) outcomes of the observational data from the computer activity and the drawings will be used as a way to probe:

- the participants' recall of particular events across the period of data capture;
- how they felt at the time;
- their reflections on these experiences; and

- their use of ICT to support their research process.

Discussions will be audio recorded and fully transcribed. Copies of the transcriptions will be returned to the participants for verification. The audio file will be available only to the researcher and her supervisors. The transcriptions will be altered to remove any identifying information prior to their use in the preparation of reports, publications and conference papers.

5. *Individual photographs & videos*: While engaging in individual discussions with the participants, the researcher will notify participants at the start of each session that their photographs will be taken or that they will be videoed. The photographs and/or the videos will show how participants demonstrate their use of ICT such as revealing how they use a certain software programme for their PhD research. The photographs and the videos will be used as a way to capture:

- the participants' behaviours when engaging with ICT;
- demonstrations of the participants' use of ICT as part of their research practice;
- the participants' verbal (videos) and non-verbal behaviours as they interact with, and use, ICT.

Photographs and video clips will be uploaded onto KwongNui Sim's desktop and a copy of the photographs and video clips will be returned to the participants for verification. The photographs will only capture the participants' actions. The videos will capture both sound and action. Photographs and videos will be altered to remove any identifying information prior to their use in reports, publications and conference presentations and papers. The photographs and the videos will be available only to the researcher and her supervisors.

15. Compliance with The Privacy Act 1993 and the Health Information Privacy Code 1994 imposes strict requirements concerning the collection, use and disclosure of personal information. These questions allow the Committee to assess compliance.

15(a) Are you collecting and storing personal information directly from the individual concerned that could identify the individual?

YES / NO

15(b) Are you collecting information about individuals from another source? Please explain:

NO

15(c) Collecting Personal Information:

- Will you be collecting personal information?

  YES (disciplines, gender, stages of study, and ICT use – applications and websites) / NO (age, race, and ICT use – passwords)

- Will you be informing participants of the purpose for which you are collecting the information and the uses you propose to make of it?

  YES / NO

- Will you be informing participants who will receive the information?

  YES / NO

- Will you inform participants of the consequences, if any, of not supplying the information?

  YES / NO

- Will you inform the participants of their rights of access to and correction of personal information?

  YES / NO

Where the answer is YES, please make sure the information is available in the Information Sheet for Participants.

If you are NOT informing them of the points above, please explain why:

15(d) Please outline your data storage and security procedures.

The recordings and transcriptions from group and individual discussions, the computer activity data capture, the scanned copies of the participative drawings as well as the photographs and the video clips will be saved on a password-protected computer at Higher Education Development Centre building. Only Sarah Stein and KwongNui Sim know the password.

All her three supervisors, however, will have the access to these data through the university server at a Sharepoint (Office 365) from their own password protected computers in their individual offices at Higher Education Development Centre building (Sarah Stein and Russell Butson) and College of Education (Jacques van der Meer).

15(e) Who will have access to personal information, under what conditions, and subject to what safeguards?

Only the three supervisors and the student of this research study will have access to personal information. The supervisors are Sarah Stein and Russell Butson from Higher Education Development Centre as well as Jacques van der Meer from College of Education, whereas the research student is KwongNui Sim, who is based at Higher Education Development Centre.

Conditions: Only the supervisors and the research student will have access to all the raw datasets through university server at a Sharepoint (Office 365) for data analysis as well as discussion purposes.

Safeguards: The supervisors' computers are password protected and the computers are in each of their own offices at Higher Education Development Centre building (Sarah Stein, Russell Butson) and College of Education (Jacques van der Meer). The locked filing cabinet is in Sarah Stein's office at Higher Education Development Centre building and only she has the key to open the cabinet.

Will participants have access to the information they have provided?

YES

15(f) Do you intend to publish any personal information they have provided?

YES / NO

If YES, please specify in what form you intend to do this?

15(g) Do you propose to collect demographic information to describe your sample? For example: gender, age, ethnicity, education level, etc.

Yes – gender and education level (e.g. the year of PhD study)

15 (h) Have you, or do you propose to undertake Māori consultation? Please choose one of the options below, and delete the options that do not apply:

(Please see http://www.otago.ac.nz/research/maoriconsultation/index.html).

NO If not, please provide a brief outline of reasons why not:

YES We have ALREADY undertaken consultation *[please attach a copy of your completed Research Consultation with Māori Form]*

16. Does the research or teaching project involve any form of deception?

YES / NO

If yes, please explain all debriefing procedures:

17. **Please disclose and discuss any potential problems**: (For example: medical/legal problems, issues with disclosure, conflict of interest, etc)

The potential problems in this study are ethical in nature and are associated with consent to install software on their ICT devices for computer activity capturing (one of the datasets), and confidentiality and anonymity of participant's identity in any of the three data collection methods as listed in question 14 above.

Consent: Student participants selected for computer activity capturing will first participate in an information session where they will be made aware of the software process used for data recording. Those who wish to continue to be involved in the study after this session will then undergo training in how to delete data, turn the software on or off and how to interpret the reports.

Student participants will be notified at the beginning of every individual discussion session that photographs might be taken and/or they might be videoed during the session. In addition, the purpose of the photographs and the videoing will be explained each time. If they are feeling uncomfortable at any particular session to photographed or videoed, the researcher will make only written observational notes during that session.

The student participants will be made aware at this session that they are free to withdraw at any time and request their data to be destroyed. They will be invited to ask questions to clarify their understandings not only of the software use, but also of their role and contribution in the study. At the completion of the project, participants will be given copies of their data (computer activity reports). They may also opt to have the software left on their systems for their continuing personal use.

Confidentiality and anonymity: All the four datasets (discussion audios and transcripts, records of computer activity, participative drawings as well as individual photographs and video filming) will be combined as a single dataset within a data analysis package (NVivo). Only the three supervisors and the research student will have access to the raw dataset. Participants will be assured via the *Information for Participants* and through discussions with prospective participants that their names will be kept confidential and that they will not be able to be identified from any data used in papers or articles reporting the study.

18. Applicant's Signature : .....

Date : .....

19. Departmental approval : *I have read this application and believe it to be scientifically and ethically sound. I approve the research design. The Research proposed in this application is compatible with the University of Otago policies and I give my consent for the application to be forwarded to the University of Otago Human Ethics Committee with my recommendation that it be approved.*

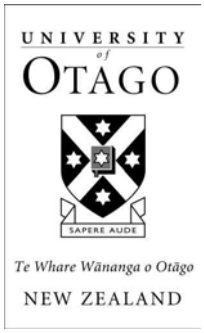
Signature of *Head of Department : …….

Name of Signatory (please print) : …….

Date : …….

Information Sheet

[Reference Number: *13/219*]
[*23rd August 2013*]



Title of Study: An investigation into the way PhD students utilise ICT to support their research process

INFORMATION SHEET FOR PARTICIPANTS

Thank you for showing an interest in this research study. Please read this information sheet carefully before deciding whether or not to participate. If you decide to participate we thank you. If you decide not to take part there will be no disadvantage to you and we thank you for considering our request.

What is the Aim of the Study?

This research study aims to investigate the role of ICT in supporting PhD students' research process at the University of Otago. The focus will be on the context(s) in which you integrate technology into your research process via different kinds of ICT devices (e.g., your laptop, your desktop, your tablet, etc.) and/or software (i.e., the applications and web services you use to support your PhD research).

This project is being undertaken as part of the requirements for KwongNui Sim's PhD.

What Type of Participants are being sought?

You are receiving this information sheet because you are one of the PhD students at the University of Otago who has not deferred your degree before.

What will I be Asked to Do?

Should you agree to take part in this research study, you will be asked to:

1. participate in a discussion group with the possibility of having photographs taken and/or being videoed (~ 1 hour);
2. attend a briefing session (~ 0.5 hour) before we install a software programme on to one of your preferred ICT devices for computer activity data capture – you will attend a couple of individual discussions (~ 0.5 to 1 hour) during and after the computer activity data capturing period;
3. attend a participative drawing session (~ 0.5 to 1 hour) that will be photographed and/or videoed, followed by an individual discussion session (~ 0.5 to 1 hour).

In all three activities described above, you will have full control of your discussion points, the use of software (you will have the ability to turn it on and off and delete records), and the ways you sketch your drawings. The decision whether photographs are taken and/or you are being filmed during the individual discussion session and participative drawing session will be left to you. We believe you will find the information recorded from the discussion group, the software, the drawings, and/or the photographs/videos interesting and very helpful for you, as you reflect on the ways you approach your study and engage in your own research process. For the entire data collection and data analysis phases, you will be invited to participate in a number of individual discussions to discuss (informally) the data collected and its relationship to your approach to your PhD study.

Please be aware that you may decide not to take part in the research study without any disadvantage to yourself of any kind.

What Data or Information will be Collected and What Use will be Made of it?

The following section describes the three types of data that we will be gathering and the process of storing them.

Discussion Data: This study involves semi-structured group and individual discussions, where the precise nature of the questions will be determined and guided by the dynamic of the group as well as individual's computer activity data capture and/or participative drawings. During the discussions, if the line of questioning does develop in such a way that you feel hesitant or uncomfortable you are reminded of your right to decline to answer any particular question(s) and also that you may withdraw from the research study at any stage without any disadvantage to yourself of any kind.

Computer Activity Data: You will be given free software that will only record the date/time, duration, and type of computer programmes you use and the date/time, duration, and type of the websites you visit over the 6 months period between September 2013 and March/April 2014. It does not record the content you browse or the content that you may develop in doing your work. It is important that you are well versed in the use of the software and informed that it has no covert functionality. You will be asked to attend a briefing session where the software is explained and you will be given training in how to control the software; this will include the ability to turn it on and off and to delete any records.

You will be invited to comment on the analysed data from your computer activity records. Data will be analysed to describe the ways in which you use, experience, and integrate ICT in your research process. Quotations from your interview discussion may be used in reports or papers on the study, but your name and identity will be kept confidential. Only the research

student and the supervisors will have access to the data collected and the data will not be used for any other purpose than this research.

At the completion of the study, you will be given copies of your data (record of computer activity) and the recording software will be removed. You will have the option to retain the software on your computer for their continuing personal use.

Participative Drawings: You will be given a briefing on the idea of the drawing. You will be asked to draw a mind map, a diagram or any conceptual structure framework that is comfortable for you based on the themes about ICT use generated from the discussion group. You will be given a week to submit your drawing. Then, you will be invited to comment on the analysed data from your drawing.

Photograph Data: You will be notified at the beginning of each individual discussion session as well as the participative drawing session that photographs might be taken and/or you will be filmed during the session. All photographs/videos that are taken will capture only what you demonstrate while you are explaining your ICT use and your drawings on the concept of ICT for your PhD research. It is important that you are aware that all care will be taken to ensure that any identifying information of yourself will not be shown on the photographs/videos. You will be invited to comment on the photographs/videos, and asked whether you will be happy for the photographs/videos to be used in the thesis document and for other presentations, reports and/or conference papers on this study.

Data will be analysed to describe how you use, experience, and integrate ICT in your research process. Quotations from your interview discussion may be used in reports or papers on the study, but your name and identity will be kept confidential. Only the research student and the supervisors will have access to the data collected and the data will not be used for any other purpose than this research.

At the completion of the study, you will be given copies of your photographs/ filming clips.

Data Storage: Data collected will be securely stored in such a way that only the research student and the supervisors will be able to gain access to it. Data will be analysed to describe the ways in which you use, experience, and integrate ICT in your study. Quotations from your interview may be used in reports or papers on the study but your name and identity will be kept confidential. Only the research student and the supervisors will have access to the data collected and the data will not be used for any other purpose than this research.

At the end of the research study any personal information will be destroyed immediately except that, as required by the university's research policy, and any raw data on which the results of the study depend will be retained in secure storage for five years, after which it will be destroyed.

Reasonable precautions will be taken to protect and destroy data gathered by email or message. However, the security of electronically transmitted information cannot be guaranteed. Caution is advised in the electronic transmission of sensitive material.

The findings of this research study will help inform us on how ICT plays a role in your research practice in higher education. The results of the research study may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every

attempt will be made to preserve your anonymity. You are most welcome to request a copy of the results of the study should you wish.

Can I Change my Mind and Withdraw from the Project?

You may withdraw from participation in the study at any time and request that your data is destroyed without any disadvantage to yourself of any kind. Withdrawal from the study is attained by simply emailing KwongNui Sim of your decision to withdraw.

What if I have any Questions?

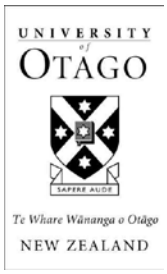
If you have any questions about our research study, either now or in the future, please feel free to contact either:-

KwongNui Sim	and/or	Sarah Stein
Higher Education Development Centre		Higher Education Development Centre
University Telephone No: - (03)4798415		University Telephone No:- (03)4795360
kwongnui.sim@otago.ac.nz		sarah.stein@otago.ac.nz

This study has been approved by the University of Otago Human Ethics Committee.
If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256 or email gary.witte@otago.ac.nz).
Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.

Consent Form

[Reference Number: 13/219]
[*23rd August 2013*]



An investigation into the way PhD students utilise ICT to support their research process

CONSENT FORM FOR PARTICIPANTS

I have read the Information Sheet concerning this research study and understand what it is about. All my questions have been answered to my satisfaction. I understand that I am free to request further information at any stage.

I know that:-

1. My participation in the study is entirely voluntary;

2. I am free to withdraw from the study at any time without any disadvantage;

3. The software recording computer activity is not a surveillance software application and I have full control over it;

4. The drawing I am going to create will be based on my understanding of the instructions provided on the themes about ICT use and I also understand that I have full control over it;

5. I will be required to supply a copy of my computer activity capture and/or my drawing and that these files will be retained in secure storage for five years, after which they will be destroyed;

6. This study involves semi-structured discussion where the precise nature of all of the questions will not be determined in advance. In the event that the line of questioning develops in such a way that I feel hesitant or uncomfortable I may decline to answer any particular question(s) and/or may withdraw from the study without any disadvantage of any kind;

7. The results of the study may be published and will be available in the University of Otago Library (Dunedin, New Zealand) but every attempt will be made to preserve my anonymity should I choose to remain anonymous.

8. I will be notified at the beginning of each individual discussion session as well as my participative drawing session that photographs and/or videos might be taken during the session in order to capture my actions as well as my words (only applicable to filming) on using and drawing the concept of ICT for my PhD research.

9. I know that the researcher will only take the photographs/videos of my actions as well as my voices (only applicable to filming) while I am explaining my use/my drawing on the concept of ICT for my PhD research and that care will be taken not to include in the photographs/videos filming any visual identifying information.

10. I understand that I will be given the opportunity to agree or disagree to the photographs/videos filming being included in for the researcher's the thesis document and for other presentations, reports and/or conference papers on this study.

I agree to take part in this research study.

....
(Signature of participant) (Date)

This study has been approved by the University of Otago Human Ethics Committee.
If you have any concerns about the ethical conduct of the research you may contact the Committee through the Human Ethics Committee Administrator (ph 03 479 8256 or email gary.witte@otago.ac.nz).
Any issues you raise will be treated in confidence and investigated and you will be informed of the outcome.