Seeing between the lines: how do PhD students use computer technologies in their research practices?

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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. Nevertheless, it is expected that PhD students will make use of various computer technologies throughout their research process (e.g., preparation phase, fieldwork phase, analysis phase, and write-up phase). This paper reports on the analysis of one of the datasets in a study that examined how PhD students use ICT to support their research practice. The analysis takes into account the relationship and/or the tensions that exist between the PhD student participants and ICT. Two discussion sessions, which included photo capture, were conducted with nine doctoral students, who self-reported as being skilled computer users in a short questionnaire. The sessions aimed to review the ways the PhD students engage with and integrate computer technologies in light of the four phases in their research process. The preliminary analysis indicates some interesting hybrid relationships between papers and computer technologies (i.e., computer devices, tools and networks) in this cohort of PhD students' daily research practices. These findings will form the basis of the other parts of analysis in the mentioned larger study to investigate relationships between the PhD students and ICT in their process of doing doctoral research.

Keywords: computer technologies, discussion data, doctoral research, e-learning, e-Literacy, higher education, ICT, postgraduate students, PhD, paper-based approaches, postgraduate study, photo data, research practice

Background and Context

As computer technologies become increasingly sophisticated and ubiquitous in higher education, understanding the extent to which PhD students integrate these technologies into their research practice is essential. This is because it is expected that PhD students will make use of various computer technologies throughout their research for both generic and specialised purposes. Nevertheless, there has been little research to date that explores PhD students' first-hand experiences of using various technologies to support their research practices. In order to achieve this end, it was deemed important to situate the data collection and data analysis as close as possible to PhD students' daily research practices. Data collection in this study therefore included:

- photographs of student participants' demonstrations of computer technologies use; and
- audio recordings of student participants' perspectives on the role of computer technologies in their process of doing a doctoral research.

The data analysed individual student participant's use of computer technologies during their research studying sessions at their daily working space. The 'explicitness' of the photographs and the presentation from their points of view at a particular moment through the audio recordings are believed to be persuasively more powerful than the conventional notes of the interviews or the answers in the surveys (Spencer, 2011).

The aim of this paper is not to debate whether computer technologies play a significant role in research practices. Rather, this paper intends to report an investigation that explored the ways PhD students' use computer technologies to support their research study, within context. PhD students from all discipline areas use

computer technologies in some form throughout the process of their research, that is, in the preparation, fieldwork, analysis and write-up phases of their studies. Therefore, it is valuable to gain insights into contexts of their work place in order to examine their computer technology use in their daily research practice. Insights from this study serve to inform, as well as to enhance, understandings and practices in the supervision and support provided for PhD students.

The current study

A search of recent publications reveals that most empirical research on postgraduate students' use of computer technologies has been focused on their e-Literacy (e.g., Blignaut & Els, 2010), communication (i.e., Lawlor & Donnelly, 2010), entertainment use (e.g., McCarthy, 2012), the use of learning management systems (i.e., Sultan, 2010), library use (e.g., Sutton & Jacoby, 2008) and knowledge consumption (i.e., Griffiths & Brophy, 2005). Such studies do not offer a clear picture of how PhD students integrate computer technologies into their daily research practices. These studies only report *what* students use and not *how* they use computer technologies. In order to address the limited explanations of the *how*, this study captured the ways computer technologies were used by a cohort of PhD student participants in their daily research practices through individual discussions and photographic sessions followed by post-analysis individual discussion sessions. The purpose of this study was to gain insights into the nature and extent of PhD students' use of ICT in the process of undertaking their doctoral research. The findings then will be relevant to the broader tertiary population, such as the postgraduate supervisors, in that the findings will help to engender awareness to what degree technological support is required to be provided to the PhD students.

Design and methods

The study adopted the interpretive, naturalist enquiry and analysis approach proposed by Guba and Lincoln (1989). This approach underpinned the decision to select a small number of participants from within a particular context to investigate the ways they use various computer devices to support their research. In other words, use of this approach provided the underlying framework and epistemological basis for exploring "the meanings and purposes attached by human actors [in this context] to their activities" (Guba & Lincoln, 1989, p. 106).

In line with Guba and Lincoln's (1989) criteria to enhance trustworthiness and authenticity, Denzin and Lincoln's (1994) interpretivist approaches to research were adapted. This meant that the research "must elucidate the process of meaning construction and clarify what and how meanings are embodied in the language and actions of social actors" (Denzin & Lincoln, 1994, p. 118). The overarching process of the research therefore comprised: focus on dialogue with the participants over a period of time (an intial discussion with a follow-up session); and observation of identifiable aspects of behaviours to seek explanation about the participants' understandings of computer technologies and their practices (close observation captured through the lens of a camera) during the discussion session.

Participants: Twenty students who expressed their interest in participation in this study were invited to complete a short questionnaire to gather their background information as well as their perceptions about their computer technology use for their research work.

The five questions making up the questionnaire were:

1. What is your discipline background?
2. What is your current research phase(s)? (Circle as many as it suits)

   a) Preparation
   b) Data Collection
   c) Analysis
   d) Write-up

3. Please indicate the percentage of workload you use computers to support your research according to the research phases you have chosen in question 2.
4. How do you rate your ability to use computers?

   a) Expert and skilful
   b) Fairly
   c) Not at all skilled

d) Not applicable

5. List your selection of ICT devices, tools and networks you use for your research.

These questions aimed at gathering some baseline demographic information (Q 1, 2 and 3) as well as some indication of students' self-efficacy in terms of their use of computer technologies for their study (Q 4 and 5). Questions 4 and 5 were based on typical questions that have been used in other self-efficacy in computer use questionnaires reported in the literature (Chaputula, 2012; Dahlstrom, Grunwald, de Boor, & Vockley, 2011; Edmunds, Thorpe, & Conole, 2012).

Nine students were selected for inclusion in the study based upon their questionnaire responses. All selected participants were studying full time through the same university. Out of the twenty students who responded to the questionnaire, these students represented a balance of discipline areas and progress through their course of study (Q2 of the questionnaire). The study 'stages' were defined as 'Early', 'Middle' and 'Final' to acknowledge the position in the general progress through the research process (e.g., 'Early' refers to a student who is in the broadly described preparation phase, while 'Final' refers to a student who may be in the process of writing up their thesis and nearing the time of submission of their work for examination). Table 1 presents a summary of balanced distribution for the participants' discipline areas and their PhD stages.

Table 1: The PhD stages of the students

PhD Stage	Participants	Discipline Areas
Early	2	Health Science
	5	Science
	6	Commerce
Mid	1	Science
	7	Commerce
	8	Commerce
Final	3	Humanities
	4	Humanities
	9	Health Science

This group of nine also all identified themselves as (b) "Fairly Skilful" in response to Q4 of the questionnaire. As for Q5, all the participants made their individual lists of ICT devices, tools and networks they used for their research work.

Discussion and photography session: An individual, hour long discussion session was held with each of the nine student participants. During these sessions, student participants found it helpful to demonstrate their views and behaviours by using the computer while simultaneously speaking about what they were doing. Photographs (with a focus on computers and study areas and not on the participants, to preserve anonymity) were taken to capture these demonstrations. Written observational notes along with photographing the participants' actions enabled the collection of richer sets of the relevant and associated verbal and non-verbal behaviours during discussion between the researchers and individual participants. Documenting data through these means provided the basis of a source of rich information, different from the typical perception data that tends to be gathered through survey and/or interview methods used in most studies about student computer technology use. This approach allowed the researchers to compare and contrast the range of different behaviours displayed across the student participant group while they were using their computer in their work place, and with limited interference to their usual behaviours.

In January 2014, the lead researcher (the first author) met with each of the nine participants to discuss the roles of ICT devices, tools and networks they reported in the questionnaire (Q5). During the discussion, the verbal communication was recorded and photographs were taken to capture:

- the participants' behaviours when engaging with their computer devices at their work place;
- demonstrations of the participants' use of computer devices as part of their research practice;
- the participants' non-verbal behaviours as they interacted with, and used, their computer devices.

Both audio recordings and photographs for each participant were imported to the data anaylsis software, NVivo,

for coding and the generation of themes. Two core themes were generated and are described in the Results and Discussion section below.

In short, this dataset facilitated the development of insights into the students' use of computer technologies (devices, tools and networks) for their daily research practice, through their voice as well as the lens of a camera. It also provided the basis for the next phase of interaction with the participants.

Follow-up discussion session: Post-analysis follow-up discussions with each participant occurred at the end of February 2014. The purpose of these sessions was to discuss the two core themes. The sessions provided the opportunity for the individual participants to talk about their use of computer technologies in the light of the generated themes and to reflect on their practices and behaviours. In this way, the researchers were able to make assertions about how the students used computer technologies within their research practice and to develop insights into the individual participants' contexts. Each discussion was audio recorded and transcribed. The transcriptions were returned to the participants for comment.

Assertions about participants' actions and understandings were examined to consider how these themes answered the research question on the extent to which PhD students use computer technologies in their research practices. The 'dialectic' of iteration, analysis, critique, reiteration and re-analysis led eventually to a joint (between researchers and participants) construction of an outcome. The joint constructions were then evaluated for their 'fit' with the data and information they encompassed. As part of this process, participants were asked to confirm that the way the researcher had portrayed findings in these joint constructions did not compromise their anonymity. This process of data collection described above provides an illustration of how particular research approaches were built into the study to enhance trustworthiness and authenticity (Guba & Lincoln, 1989). It also exemplifies how this study encouraged participants to take on a "researcher-like" role and experience the invested outcome of the study (Green, Rafaeli, Bolger, Shrout, & Reis, 2006). In addition, the study provided the environment to focus on the student voice, and the students' on-going use, experience, and perception of technologies (Conole, de Laat, Dillon, & Darby, 2008).

Results and discussion

Two core themes emerged from the results of the analysis of the discussion and photography sessions: Paper *or* Computer? and the so-called 'e-Literate'. These themes show how our study has highlighted aspects of PhD student use of computer technologies in their research process that have not been reported before due to the limitations of the data gathering approaches used in other studies.

Theme-1: paper *or* computer?

This theme focuses on the role played by various computer technologies used by the participants alongside their use of paper-based approaches. The theme serves to highlight the extent to which participants were using computer technologies and/or paper-based practices to support their research practices.

Findings from the analysis of both audio recordings and photographs presented in Figure 1 showed the dominance of paper-based approaches in the students' daily research practices, even though the students were surrounded by various computer technologies in their work place.
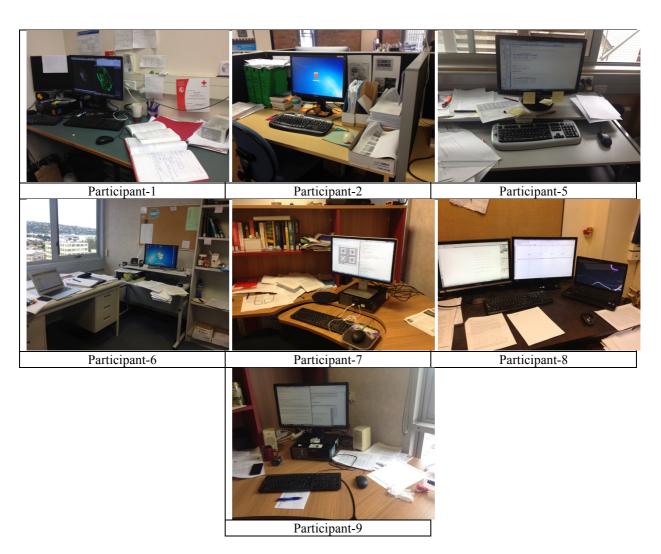
Figure 1: The work place setup of each of the participants

As shown in Figure 1, seven participants set up their work place in a way in which they were able to apply paper-based approaches (they read from the printouts and made notes on paper) when working on their research. For example, their main computer for work was sitting in a position where it allowed them to work on paper at the same time. The emphasis on the paper-based approaches is illustrated by the layout of their table and dominated by paper-based resources such as printed papers, sticky notes, books and other stationery (e.g., pens and highlighters). As for participants 3 and 4, they 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 computer technology approaches. In the individual discussions with these two participants, 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, participant 3 said, "[Computer devices] 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, participant 4 said, "I like books (…) I write letters (…) although [computer technologies] are crucial."

In other words, a review of the daily use of computer devices as well as paper-based artefacts revealed that all the participants agreed that paper-based approaches were significant in their research processes. Most of the seven participants whose study places were photographed expressed that, computer devices were only tools that assist them to achieve their aims their research activity (e.g., participant 6 said, "I need to use *SPSS* for sure (…) But there are times I like big calendars rather than Google calendar, which are more visualised"). While most of them were aware that they used paper-based approaches more than their main working computer, they perceived that this was due to a dependence on paper-based approaches inherent in higher education (i.e., participant 5 said, "We evolve from the old fashion styles (paper-based approaches) (…) I am still computer illiterate"). Thus, it is seemed that, for these students, computer devices are simply tools that are used to access documents that the

students then print out and read before they are filed in the folders.

All the participants in this study indicated a preference for, and dependence on, paper-based approaches to support their research practice. Incidentally, all read their research materials from paper when they were actually working on their research in a digitalised environment. It is easy to consider that the digitalised environment implies the importance of computer technologies in the process of doing doctoral research but their preference suggested a different scenario. We are not suggesting that the use of paper-based approaches in the research process is inappropriate, but simply pointing out that computer technologies in this process only seem to be tools that connect digital resources to a printer and the printed materials are then the main working 'space'. This process of transferring information from computer technologies to papers and then back to computer technologies eventually raises the question of these student participants' proficiency in using computer technologies for their research work.

In addition, we were not surprised to see the degree to which students were using paper-based approaches over computer devices, but the ways they used their computer technologies had not been anticipated. For instance, participant 1 who had dual screens only used one; the other was turned off and used as a 'to do board' to which he added sticky notes (see Figure 2). At the same time, participants 6 and 8 had obvious presentations of different computer devices in their work place as depicted in Figure 2. With those devices, both participants 6 and 8 'distributed' their tasks onto different devices, even though all those tasks could have been carried out on the main working computer. For example, participant 6 searched for literature on the desktop, had his laptop turned on at one side for email and was connected through *Messenger* via his smartphone. This 'hybrid state' of computer technology distribution in the work place seemed to focus more on 'being connected' (email and *Messenger*) than on 'producing work' in relation to the doctoral disseration. As for participant 8, he had two extended screens active for his research work and his laptop was turned on at the side for 'entertainment' purposes (e.g., *Youtube* and *Facebook*). Again, such computer technology distribution expressed needs of 'being connected' (*Facebook)* in conjunction with individual working/studying styles (i.e., listening to music or watching clips on *Youtube* while working on research).

In the light of these observations, we wonder what is the role of computer technologies for a PhD student in the process of doing doctoral research? Could it be that as long as the students are comfortable with what they are using for their research and study, there is no reason to compare paper-based approaches and their computer technology usage? Or could it be that the students could just distribute the computer technologies for different tasks as preferred, as long as the distributions suit their working patterns? Whichever possibility it is, what is the role of computer technologies within higher education, particularly in the research domain?

Theme-2: the so-called 'e-Literate'

This theme focuses on the abilities of participants to use various software applications as part of their research practices. The theme draws attention to the relationship between being 'e-Literate' and doing a PhD research study.

According to Person and Young (2002), e-literacy is about the capacity to understand the broader technological world and to use technological knowledge or capability to interact with technology. All the participants self-reported their ability to use computer devices as 'farily skilful' in the questionaire (Q4 of the questionnaire used in the recruitment phase of the study). Findings from both the audio recordings as well as photogragh analysis, however, indicated low e-literacy among the participants in their daily research practice (through close observation) even though they perceived they were 'e-literate' in their research field (through individual discussions). The photographs presented in Figure 2 provide illustration of these practices and indications of why we determined that their e-literacy was 'low'.

Participant-1	Participant-2	Participant-3
Participant-4	Participant-5	Participant-6
Participant-7	Participant-8	Participant-9

Figure 2: Photographic capture of the participants' ways of using ICT

Participant-1 chose not to learn to use the programme (on the right) to present his chemical models even though he was asked by his supervisors to do so. He argued that he said he could not see the differences between the two software programmes for model presentations. During the discussions with participant-1, it became evident that his decision was based on his choice to stay within his 'comfort zone' as he explained that learning to use a new application was seen as a 'burden' for him. Participant-2 and participant-4 arranged all their referencing articles and word documents for each of their thesis chapters on the desktop screen instead of using the folder system. Both participants explained the rationale for this behaviour during the discussion sessions. Participant-2 found it more 'secure' to do so as she said she could 'see' the arrangement clearly on the screen so that she would not 'lose' any file. Participant-4 admitted that she did so because she did not know how to create a folder – "I can do a PhD study but I don't know how to create a folder." Participant-3 created a bibliography list using an *Excel* spread sheet rather than using a specific bibliography software programme. Participant-3 described his *Excel* bibliography system as 'better' and 'more effective' than a bibliography system, such as *Endnote*. Similar to participant-1, the reality expressed was that participant-3 found it a 'time-consuming effort' to learn using a specific bibliography software programme.

Participant-5 had no idea how to use *Outlook calendar* and/or electronic 'stickies', even though she is a competent data analysis package (*SPSS*) user. While it could be argued that applications such as *Outlook calendar* and 'stickies' are less complicated than *SPSS*, participant-5 chose to learn and master the latter. Discussions with the student revealed that for her, there was no choice involved, as she needed *SPSS* for her data analysis, whereas the use or non-use of applications such as *Outlook calendar* and 'stickies' was based on personal choice. It seemed that for this participant at least, learning to use an application only takes place when there is a 'rewarding' outcome. In this case, the learning of *SPSS* contributed to participant-5's doctoral dissertation. As for *Outlook calendar*, she could easily have used paper-based calendar to replace it and she could substitute the 'stickies' with a paper-based version. For her, the use or not of *Outlook calendar* and

'stickies' would not have had any impact on her process of producing a doctoral dissertation. Displaying similar tendencies, participant-6 and participant-8 printed out their articles, highlighted the relevant sentences (using highlighter pens), made notes by hand and then typed these notes into a Word document. Participant-7 and participant-9 split their main screens into different parts for different software programmes instead of using the dual screens to have the different programmes visible and easily accessible simultaneously. Such working processes provide the basis of our puzzling about the PhD students' proficiency in using computer technologies for their research work. Their behaviours associated with activities that support their research work reflected personal preference, task relevance and priority.

This finding suggests that this cohort of PhD students is less reliant on the various software applications installed on their computers than they are on the paper-based artefacts and/or their individualised ways of using the computer technologies. Research-orientated client-side applications, such as bibliography programmes (e.g., *Endnote*), planning software (i.e., 'stickies'), management packages (e.g., folder systems) and other applications relevant to research practice (e.g., calendars, task applications) and even the use of dual screens were noticeably absent from the students' daily research practices. Given the benefits of using various software applications in the PhD research process, we were expecting a higher and more proficient use of these applications. The low use and low reliance on these software applications raises an interesting question: To what extent has computer literacy and e-literacy more broadly become an essential component within the higher education environment?

Evidence gathered during the discussion meetings suggested that, for most of these PhD students, their levels of e-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 used them to achieve what they wanted in their research, and so manipulated their use to suit themselves. For example, participant-1 said, "We just have to practice (using the computer devices), trial and error […] and I got (what I want)". Participant-8 too said, "We rely too much on the computer […] we should manipulate it instead (to achieve what we want)." With the arguments stating the importance of computer technologies in higher education nowadays (Aspden & Thorpe, 2009; Dahlstrom et al., 2011; Guidry & BrckaLorenz, 2010; Smith & Caruso, 2010), could we accept this justification? What can we make of the so-called 'e-literacy' among PhD students in their research practices as represented in this study?

In summary, the findings from this study are somewhat surprising, given that most current research literature highlights the key role that technology plays doing doctoral research, and argues that the majority of today's students, are particularly computer 'savvy'. The two themes that emerged from this study differ significantly from outcomes of previous studies reported in the literature. Because this study used a combination of discussion and photographs instead of conventional survey and interview methods, we were able to focus more closely on teasing out the students' daily research practice behaviours within their own contexts, and to explore how and why students use computer technologies in more depth.

Conclusion

The purpose of this study was to investigate the ways PhD students use computer technologies to support their research practice. This study, of which a subset of the analysis in a larger project is reported in this paper, offers important insights into current understandings of postgraduate students' e-literacy and the use of computer technologies in their doctoral research. In this study, the focus was on data gathered via discussion sessions supported by the photographs.

It is hoped that the findings generated from this study so far will help promote a deeper conversation about the ways postgraduate students use computer technologies in their research. Perhaps research on larger and more diverse groups of students could be considered to obtain more representative data of the postgraduate student population, as this study is only focussing on a small group of students at one university. Additionally, visual and situated behavioural data could be employed in researching computer technology use as such approach offers new insights not found in data gathered through questionnaires and surveys.

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– 26th November 2014 will not have been undertaken.

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