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The development of digital competence in first year pre-service teachers.

Claudette Ann Muller

A thesis submitted to the Wits School of Education, Faculty of Humanities, University of the Witwatersrand in fulfilment of the requirements for the degree of Doctor of Philosophy

Johannesburg 2017

Abstract

This thesis reports on the first year pre-service teaching students' development of digital competence at a South African university in 2013 and 2014. The aim of the study was to investigate the students' levels of digital competence as they commenced their first year of study. I also examined the barriers and enablers, as identified in the literature, and their impact on the students' successful engagement with Information and Communication Technologies (ICTs). In addition to this, the possible influence of computer attitude and a belief in one's own ability (self-efficacy) supplement the research findings in this area. I present quantitative and qualitative data that explore the students' digital competence levels and their understanding of what it means to be digitally literate. A definition particular to this group of students is proposed. In their definition of digital competence, the majority of the first year pre-service teaching students perceived digital competence to be a functional skill. This is the ability to operate digital devices and their relevant applications in the quest to learn and become self-reliant. This definition is aligned to Covello's (2010) description of an understanding of how to use computers and application software for practical purposes. This ability to functionally operate various devices (FutureLab, 2010), the ability to use computers and other technology to improve learning, productivity and performance (JISC and Mc Hardy, 2013), links to one part of Ferrari's (2012) digital competence definition as the knowledge, skills, attitudes, values and awareness required when using ICTs and digital media.

After completing a baseline digital competence test as they entered the HEI, I found that 43% of the first year pre-service teaching students failed the test. I identified three main factors that impacted negatively on a first year pre-service teaching student's engagement with ICTs and ultimate development of digital competence. These include inexperience with ICTs, access and user-unfriendliness of software. Four main enablers to the effective use of ICTs include previous experience using ICTs, previous and current access to ICTs, user-friendliness of software, and finally, support in the form of support material or people.

Using quantitative findings obtained from the completion of the Loyd and Gressard Computer Attitude Scale (CAS), I ascertained the students' computer attitudes. Through the application of the Murphy's (1989) Digital Self-Efficacy test, the current levels of the students' digital self-efficacy (DSE), or beliefs in their own abilities, were established. I

found no correlation between computer attitude and a student's digital competence. The majority of students who failed the baseline test had a positive computer attitude. I also found the majority of students surveyed had a strong or very strong belief in their own ability. The majority of the students who passed the test had a very strong DSE and the majority of students who failed had an average to strong DSE. Students who passed the test tended to have higher DSE levels than students who failed the baseline test. A strong belief in one's own ability was found to be a strong determiner in learning to become digitally competent.

A unique application of Actor Network Theory was employed in the data analysis. The analysis methodology was informed by an adaption of Barab, Hay and Yamagata-Lynch's (2001) node components. The use of Actor Network Theory as an analytical lens in the data analysis, confirmed the importance of zooming in on and unpacking a student's network of learning to better understand the hidden processes at work. Through an analysis of six students' networks of learning, I found that each student's learning network was unique. Using actor network theory to scaffold my analysis it became apparent the differences in the students' learning networks told a more important story than the few commonalities. The only commonalities evident between the six students in the moment I unpacked each learning network were that they were both initiators and participant in their networks. They interacted with digital devices and were not first time ICT users. These commonalities seem quite immaterial when compared to a minimum of 16 differences. A few of the identified differences include the digital resources the students relied on, their computer attitudes, levels of digital self-efficacy and their baseline test results.

My study contributes to knowledge in four ways. Firstly, I establish the digital competence skills of first year pre-service teaching students. Secondly, I identify the barriers first year pre-service students encountered when using ICTs. Thirdly, I look at the possible impact of computer attitude and digital self-efficacy on the development of digital competence. Finally, I detail the networks of learning to be digitally competent. Through this expansion of students' networks of learning, the connections between the various nodes and actants at work become apparent. This gives readers insight into what nodes are at play within these networks and what the pre-service teaching students identify as significant in their learning. In this study, I confirm the necessity for a first year digital competence or ICT course. My study shows that the students entered the HEI with low levels of digital competence and encounter multiple barriers when accessing ICTs. While literature suggests computer attitude

impacts on the development of digital competence, in the reality of my study, I found digital self-efficacy to have a higher statistical correlation with digital success. Studies such as mine provide detailed descriptions and analyses of the practice of coming to be digitally competent. The identification of, and investigation into the possible factors impacting on a pre-service teaching student's development of digital competence better assists Higher Education Institutions and course designers alleviate possible barriers, while increasing enablers.

Declaration

I declare that this thesis is my own unaided work. It is submitted for the degree of Doctor of Philosophy in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.



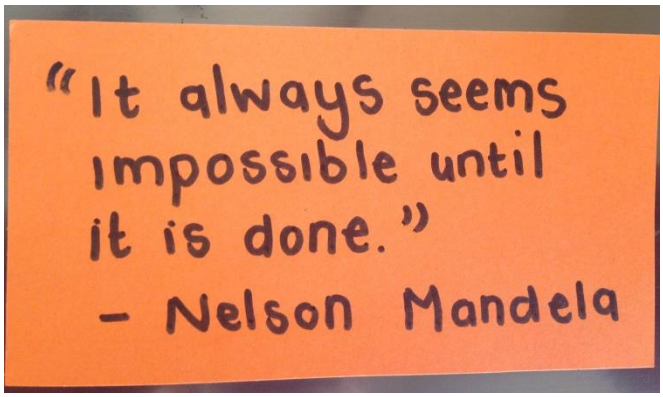
Claudette Ann Muller

28th day of March, 2017

Acknowledgements

My grateful thanks go to the following:

- My supervisor, Professor Tony Lelliott, whose selfless time and care were sometimes all that kept me going. I know you read every word and I thank you for that. I appreciated every insightful comment, well done, and big green tick.
- My daughter, Liezl Muller for her motivation and inspirational quotes that helped me get through many difficult times.
- My daughter, Gemma Muller for the endless mugs of hot chocolate, shoulder massages and alcoholic smoothies.
- My mom, Carol Thompson for reading and editing my writing. Thank you for helping me with the girls while I spent six years in front of a laptop.
- My husband, Werner Muller. Thank you for your support and for understanding when dinners were "hunt and gather" moments.
- My family, Alison Nitch, Angela Muller, Richard Muller, Vanessa Muller, Terry Jones, for always asking what I was writing about and for appearing interested when I explained.
- My friends and colleagues – for sticking with me throughout this whole process. Sorry that I turned into a totally reclusive nerd. I am back!
- Farrah Craze for being my inter-rater reliability person. You were an impartial emotional and intellectual sounding board and friend.



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List of Abbreviations and Acronyms

AT	Activity Theory
ANT	Actor Network Theory
CA	Computer Attitude
CHE	Council on Higher Education
CoP	Community of Practice
DSE	Digital self-efficacy
FYE	First Year Experience
HEI	Higher Education Institution
ICT	Information and Communication Technologies
RQ	Research question

Chapter 1 - Introduction

"Information and communication technology (ICT) is fundamental to the implementation of e-education and offers greater opportunities to access learning, redress inequalities and improve the quality of teaching and learning…e-Education requires that teachers, managers and administrators in public schools and colleges have the knowledge, skills and support necessary to integrate ICT into teaching and learning. ICT has brought new possibilities into the education sector, but at the same time, has placed more demands on the skills' level of teachers."(Hindle, 2007, p. i), foreword by the Director General, Guidelines for Training and Professional Development in ICT, Department of Education.

Due to schools focusing their attention on the use of Information and Communication Technologies (ICTs) as both management and teaching-learning tools, the school environment as well as the role of the teacher has changed (Askar & Umay, 2001; Britland, 2013). The teacher is now seen as key to the effective use of ICTs in the educational system (Blignaut, 2006; Nash & Moroz, 1997; Sarkar, 2012; Zhao, Hueyshan, & Mishra, 2001) and therefore it is important to understand teachers' attitudes to ICTs and identify factors that may influence these attitudes to ICT use. The development of the required skills as stated in the quote above could be seen to be a responsibility of the tertiary or higher education institution that the pre-service teacher attends as McMahon (2014) points out that in order to be productive in their chosen careers, university graduates need not just to show competence in computer applications, but demonstrate critical and creative mastery of digital information and tools. Universities therefore have a responsibility to equip students for this need, producing graduates that are confident and ethical participants in an increasingly intricate digital society (McMahon, 2014)

The Higher Education Institution (HEI) is an institution where students can study a full-time four year pre-service teaching degree. The above quote from the Department of Education's guidelines calls for increased ICT integration in teaching and learning processes. This can only be effectively achieved if the teacher possesses the necessary skills. According to National Council for Curriculum and Assessment in the United Kingdom (NCCA 2004), there are three main frequently cited arguments for promoting the inclusion of ICT in education. The first relates to the potential benefits of ICT for teaching and learning, which may include gains in students' achievement and motivation. The second argument acknowledges the pervasiveness of technologies, which leads to the subsequent need to

acquire digital competence to be functional in our knowledge society (Eshet-Alkalai, 2004). As a consequence, the third argument warns against the dangers of the current digital divide that needs to be tackled to allow all individuals to benefit from being active in the digital domain (Ferrari, 2012).

In my study I investigated the level of digital competence that students possessed when they entered the HEI to commence their four year pre-service teaching degree and identified the factors impacting on a student's development of digital competence in their first year of study. Robinson (2008) describes the digital age as a time when technology and demography reshape the fundamental structures of industry and education (Robinson, 2008). While digital technologies are now ubiquitous, the ability to use them with the confidence to apply them with a high level of complexity across a full change of contexts is far less evident. As technologies continue to evolve at a rapid rate and the industries which graduates enter evolve equally rapidly, the need to produce graduates that are immediately digitally ready but also able to adapt to the technological challenges of the future is a pressing one (McMahon, 2014). Fifteen percent of the students who participated in my research mentioned advancing technology as the driving force for them to become more digitally competent.

Researchers privilege the necessity of developing digital competence for full participation in life (Sefton-Green, Nixon, & Erstad, 2009), while education policy documents often emphasise the need to invest in digital skills enhancement for economic growth and competitiveness (European Commission, 2010; Hartley, Montgomery, & Brennan, 2002). Computer-related proficiency, according to other researchers is the key to employability and improved life chances (Sefton-Green, et al., 2009). A 40 year old male student who completed the online questionnaire in my study mentioned having missed out on job opportunities due to his lack of digital competence: *"the reason is that I have been having this void and phoby [sic] in me whenever I come across anything computerised. I also missed a lot of job opportunities by not being computer literate."* In the last decade competences related to the use of ICTs and technologies have started to be understood as *life skills*, comparable to literacy and numeracy, therefore becoming "both a requirement and a right" (Organisation for Economic Co-operation and Development (OECD), 2001, p. 3).

An outline of my study as well as the theoretical framework that was used to guide my study is provided here. This chapter also offers a background to my study, a statement of the

problem, the purpose of my study and the research questions. My position as a researcher and some limitations to my study and an argument for the importance of the study and its contribution of new knowledge to the field of digital literacy or digital competence is presented.

1.1. Background to my study

The higher education institution in which I conducted my research drew up a strategic framework, which set out the vision of the HEI to pursue in the years 2010 to 2022. It identified the strategies needed to achieve this vision. This framework indicated that as one of the eight strategic priorities was that by 2022, the HEI would be an IT savvy university that used technology to enhance all its core processes. This included providing new and innovative ways of engaging students and staff in academic activities. One of the 13 strategic objectives was that students possess computing devices.

> Ensure that students possess computing devices and are connected to the HEI irrespective of time or place, and are able to use their own or provided computing devices as knowledge access and creation tools in a connected way. (Indicator b, page 35).

Looking back at the earlier *HEI 2013 Strategy document* (Higher Education Institution, 2011)[1], one of the indicators was that by the end of 2012, eLearning pedagogy would be introduced to ensure that teaching and learning made appropriate use of mobile computing devices (indicator f, page 16) and that by the end of 2012, all courses would be supported in the creation and maintenance of an active eLearning presence, which contained at least the essential information for the course and a facility that would allow all course participants to communicate electronically (Indicator f, page 17, *HEI 2013 Strategy document*, Higher Education Institution, 2011).

When reading the later HEI 2022 Strategic Framework, no mention of the above two 2013 indicators was made. The assumption here is that these goals have been met. The new strategy document now stated the need to ensure that a strong element of innovation underpinned the way in which we chose, created and applied ICT to academic and support activities within the university (Indicator f, page 35, *HEI 2022 Strategic Framework*).

While I feel that the above goal is a step in the right direction, I am concerned that the possibility of novice ICT users still existing amongst the first year student cohort is

[1] I refer to the university at which this study took place as the *Higher Education Institution* (HEI) for anonymity purposes.

overlooked. Digital competence is both a requirement and a right of citizens, if they are to be functional in today's society. However, it has been shown that citizens are not necessarily keeping up with the evolving needs derived from rapid technological change and uptake (Ferrari, 2012). A study at another South African university found the number of students failing computer literacy tests was increasing every year (Dednam, 2009). With emphasis on a blended approach to teaching, these students' studies may be disadvantaged due to their lack of digital expertise. A blended approach is one that involves both traditional face-to-face contact with the student group, as well as an online component. This online component may be the use of an online site as a course note repository or may involve the use of online collaboration and communication tools, such as chats, discussion forums and wikis. The first year of tertiary education is notoriously difficult with a high drop-out rate (Letseke & Maile, 2008; Van Wyk, 2009), without the added burden of having to access course material online and interact with peers in an online environment. The Council on Higher Education (CHE) and Department of Higher Education and Training (DHET) expressed concerns over the high dropout rates at South African universities. South Africa's university dropout rates are high by international standards. They have been around 50% since the 1990's, and the most recent statistics in 2012 indicate a further increase in dropout rates to 58%. Statistics at the HEI at which I conducted my research showed a 15% dropout rate in students enrolled in a pre-service teaching degree in 2009 when advancing to their second year (Academic and Information Systems Unit, 2009).

The Council on Higher Education (CHE) published a proposal for curriculum reform in South Africa. The data they collected on first year attrition rates and graduation in regulation time support the contention that much of the poor performance in higher education can be attributed to the articulation gap between school and higher education. The CHE goes on to state that success and failure in higher education is the result of a complex interplay of factors, namely social, cultural and material circumstances (Council on Higher Education, 2013). The data they collected showed that only one in four students in contact tertiary institutions graduate in regulation time. They estimated that 55% of the tertiary institutions intake will never graduate. Disparities exist within the race groups in South Africa. Less than 5% of African and coloured youth succeed in any form of higher education (MacFarlane, 2013).

The CHE states that poor academic preparation at school is the dominant learning related reason for poor university performance and argue for radical changes to undergraduate degrees. It suggests implementing a flexible curriculum structure in which the duration of three year degrees and diplomas as well as four year professional bachelor's degrees are increased by one year to meet the needs of the majority of the student intake. Secondly it suggests that the new curriculum structure should be flexible to allow for the diversity in preparedness of the students. Students who can complete the programme in less than the formal time should be permitted to do so (MacFarlane, 2013). The report continues to advise that the level of dysfunction in schooling must continue to be a primary focus. However, the researchers predict that from their current analyses of the school sector, there is effectively no prospect that will be able, in the foreseeable future, to produce the numbers of well-prepared school leavers that higher education requires. As a result, higher education institutions (HEIs) have two choices. Firstly they can allow the status quo to persist. Alternatively, they can undertake to act on factors that are within their control to address the conditions impeding student access (MacFarlane, 2013). Pertinent to my study is the recommendation that HEIs need to deal constructively with diversity in students' education, linguistic and socio-economic backgrounds (Council on Higher Education, 2013). Assumptions of a student's prior experience with ICTs and level of digital competence cannot and should not be made.

Consider the White Paper on e-Education's policy goal stating that

> "every South African learner in the general and further education and training bands will be ICT capable, that is, use ICTs confidently and creatively to help develop the skills and knowledge they need to achieve personal goals and to be full participants in the global community by 2013" (Department of Education, 2004, p. 17).

It is evident from the above extract that a Higher Education institution needs to ensure that the teachers who graduate are themselves ICT capable and are adequately prepared to effectively use ICTs in their teaching. With pressure being placed on pre-service teaching students both from within the institution and from the Department of Education to develop a certain degree of digital competence, the value of my research project lies in its efforts to investigate what student conceptions of digital competence are and how they come to be digitally competent during their first year of study. Findings from my study, such as, identifying factors that impact on the development of digital competence can contribute to determining best practice to promote digital competence in current and future students at the

HEI. It may be possible to extend these findings to other South African higher education institutions and to students in other countries that face similar challenges to those experienced by first year students in South Africa.

1.2. Statement of the problem

My doctoral research has its origins in a divisional debate within the HEI as how to best develop students' digital competence skills. The educational focus of the division I was a member of, was on eLearning, educational technology and the development of digital competence. Some division members argued that a first year digital competence or ICT course was unnecessary as the prospective students would have received tuition in ICT at their secondary school. Comments such as "who is not digitally literate these days" were bandied about. Debate around the structure of a digital literacy course revolved around whether the students should be taught specific digital or computer skills "just in case" (JIC) they may need them some time in the future, or rather teach them as the need arises - "just in time" (JIT). In adopting a *just-in-time* approach, proponents believe that the skill will hold more value for the student and they will be more likely to retain it. *Just-in-case* advocators on the other hand argue that an individual will not be able to use a computer effectively without some initial instruction in basic digital skills (Goveia & Soule, 2003).

The "hole-in-the-wall" project launched by Dr Mitra in 1999, involved a high speed computer, connected to the Internet which was placed in a wall for anyone passing by to use (Simmons, 2005). Mitra found that children were attracted to the machine and within minutes had figured out how to point and click and by the end of the day they were browsing the Internet. It was found that, given access and opportunity and no instruction, the children quickly taught themselves basic computer literacy skills (Connor, 2002). This prompted Mitra to propose that the acquisition of basic computing skills by any set of children can be achieved through incidental learning, provided that the learners are given access to a suitable computing facility, with entertaining and motivating content and some minimal (human) guidance (Hiwel, 2005). This project involved children and while it would appear that these children were able to use the device in a *just-in-time* approach, a certain degree of guided instruction may be needed to help the adult student access a technological device for the first time. After that a *just-in-time* approach may be feasible. One of the HEI 2022 strategic objectives is to provide continuous capacity-building, training and just-in-time learning

opportunities to improve student and staff capacity to exploit technology to achieve excellence in their work, (indicator k, page 35, Higher Education Institution, 2013).

There is an increased interest in ICTs in higher education institutions as people are moving towards a new kind of society in which ICTs are considered a basic requirement. This involves a reformulation of the nature of learning and the requirements of a graduate (Czerniewicz, Ravjee, & Mlitwa, 2005). As I see South Africa finding its way in the development of ICT skills in its people, a study such as mine is needed to investigate the ways in which individuals, especially first year pre-service teaching students develop these ICT skills and ultimately come to be digitally competent. When these students graduate they will teach children in schools and hopefully develop the same ICT capability in them, resulting in a more ICT or digitally competent population.

Computer or Digital Literacy, as a course with value within the HEI was possibly undervalued by staff who stated that "everyone is already digitally literate". Generalisations about current students as 'millenials' and 'digital natives' (Prensky, 2006) have created assumptions that such students are digitally literate (Strauss & Howe, 2006), and it does seem that students born in or after 1982 (as the majority of students in this research project are) are used to technologies and expect them to be integrated into their learning (Brown, 2000; Frand, 2000; Oblinger, 2003). However, other studies, (Kennedy, Judd, Churchward, Gray, & Krause, 2008; Ladbrook & Probert, 2011) have shown that many students, including millennials, have a tendency to value those technologies that have an immediate benefit to their lifestyles rather than as learning and productivity tools. The diversity of students entering the HEI warns us against making any pre-judgements about students' existing capacity, or lack thereof, to fully utilise digital technologies for learning.

The Information and Communications Technology (ICT) course that was investigated in my research project changed designers in two consecutive years. Initially it formed a component of another course and then it became a credit only course, i.e. a student only had to pass it in order to receive the endorsement. The assumption that all students are digitally competent is contrary to my findings in 2009 at the same HEI where novice ICT users made up 35% of the first year students registered for the pre-service teaching degree (Muller, 2009). As a result, I began to question why so many students have not had exposure to ICTs and training before they enrolled at the HEI. To ensure the effective development of digital competence in the

students, I felt that it important to explore the factors that may impact on a student's effective engagement with ICTs. In addition to the possible factors of age, gender, race, physical factors, socio-economics, language, culture, geographic location, I focused on the impact that factors of attitude and self-efficacy played on the individual's development of digital competence. Such factors are more able to be amended and improved, whereas those of age, race, gender, language, culture are constant. It is possible to change an individual's attitude towards the use of ICTs, but their demographic characteristics are inherent.

The value of my study lies in establishing the digital competence levels of first year pre-service teaching students entering the HEI. Findings from my study will inform the HEI and other South African HEIs what the major issues are with regards to access and use of ICTs. The HEI will then have a better sense of the barriers that first year pre-service teaching students face when accessing ICTs. I established whether there were any differences in the process of coming to be digitally competent, as well as the barriers or enablers encountered, with regards the student's race, gender, age or other demographic factors. As I documented the students' process in which they came to be digitally competent, I attempted to establish a pattern or pathway that they followed. Such pathways involved a change from being a novice ICT user to a more advanced user. Models of skill acquisition were explored to examine how the students achieved a desired level of digital competence.

Qualitative researchers do not always think about who are going to use the research findings and how useful it may be to them, but prefer to understand the case, and answer to the *who, what* and *how* questions, and not so much on how findings can be used by others. The function of research is important and the role of researcher and practitioner within it. The researcher's aim is to analyse a situation in order to understand it better and then to disseminate this new understanding in order that others might share in it. I share my findings with the practitioners in my study. The first year digital competence course designers and presenters can then make use of the fresh insight and effect change in the first year course. If my research merely aimed to describe a studied case then an analysis of what happened would suffice. However I want to take it one step further. I offer the opportunity for the course designers and presenters to change their practice as a result of understanding the studied case. I presented the analysis in a form that emphasised the action that may be taken to facilitate that change. Indeed, this is what Bassey proposes:

> A fuzzy generalisation carries an element of uncertainty. It reports that something has happened in one place and that it may also happen elsewhere. There is a possibility but no surety. There is an invitation to `try it and see if the same thing happens for you.' Bassey (1999:p.52)

1.3. Purpose of my study and the research questions

While establishing what the first year pre-service teaching students entering the HEI digital competence levels were, I also identified factors that impacted on a student coming to be digitally competent. I was specifically interested in the role that computer attitude and digital self-efficacy could have on this network of learning to become digitally competent.

The overarching question which my research sought to answer is:
What role do digital self-efficacy, computer attitude and other factors play in the development of digital competence in first year pre-service teachers at the HEI*?*

This entails consideration of the following sub-questions:

1: What are first year pre-service teaching students' perceptions of digital competence?

2: What are first year pre-service teaching students' current levels of digital competence?

3: What factors inhibit or afford the development of the first year pre-service teaching student's digital competence?

3.a: What relationship is there (if any) between computer attitude and a student's attainment of digital competence?

3.b: What role does a belief in one's own ability to use ICTs (self-efficacy) play in the development of digital competence?

4: How do first year pre-service teaching students come to be digitally competent?

My research established what the first year pre-service teaching students, entering the HEI to begin their four year teaching degree's current levels of digital competence were. Research questions one and two are answered in chapter five. I examined the factors that may impact on these students' development of a required level of digital competence in chapter six. Focusing specifically on the role that computer attitude and digital self-efficacy may play as either an enabler or inhibiter to this development, I drew conclusions to the possible impact that these two specific factors had in chapter seven. Finally I documented the process that a student went through in their development of digital competence. Research question four is answered in chapter eight.

1.4. An outline of my study

Here I provide a brief overview of my study which explores the ways in which first year pre-service teaching students came to develop a degree of digital competence at a HEI. These adult learners, ranging in age from 18 years up, encountered certain factors that could act as barriers to their effective use of ICTs. While the term, digital literacy or competence, is explored further in my study, both in the literature as well as from the student participants' points of view, at this point it is defined to mean the possession of a certain level of autonomous ICT skill. This being the ability to use digital devices, such as computers, the Internet, mobile phones, laptops, and any other digital device independently or being able to seek assistance from a more skilled other should the need arise.

In addition to establishing the students' actual digital competence levels through the use of a baseline test at the onset of my study, I was also interested in what the students perceived digital literacy or competence to be. By comparing literature definitions of what it means to be digitally competent and actual participant definitions, I arrived at a suitable definition of digital competence for my study in chapter five. As the students asked themselves what it meant to be digitally competent and "how do I know when I am digitally literate?" I described and interpreted their experiences of coming to be digitally competent.

In order to explore how students came to be digitally competent, it was necessary to identify possible factors that may impact on their use of digital devices. From reading relevant literature, it appeared that while the students may face certain obstacles, they also encountered phenomena that facilitated their digital use. My focus was on whether computer attitude and digital self-efficacy, affected a student's development of digital competence. By adapting existing instruments, I determined the students' computer attitude as well as digital self-efficacy levels and established whether these affected their development of digital competence. Research has shown that an individual's attitude towards the computer is a major predictor for its future use (Myers & Halpin, 2002). An individual's attitude towards learning about and using computers can be measured through asking them about their liking of computers, the perceived usefulness of computers as well as their computer confidence and anxiety towards using computers (Nash & Moroz, 1997). The Loyd and Gressard Computer Attitude Scale (Loyd & Gressard, 1985) was adapted to include other digital devices, not just the computer. Self-efficacy, a construct developed by the social cognitivist theorist, Albert Bandura, is the belief in one's own abilities that one has the capability to perform a particular

behaviour. It follows that digital self-efficacy is an individual's belief in their own ability to competently use ICTs (Compeau & Higgins, 1995).

The students' attitudes and self-efficacy levels were measured quantitatively through the use of scales (appendices B and C). The identification of factors that may have impacted on the student's development of digital competence was established through the use of an online questionnaire (appendix A) and interviews (appendix E). Subsequent to this, a narrative description and analysis is provided of a selection of the students' actual experiences with ICTs. Conclusions were formulated as to how first year pre-service teaching students at the HEI came to achieve digital competence.

1.5. The theoretical location of my research

Having provided the background, the purpose as well as an outline to my study, I now locate my research in broader contexts. The paradigm informing my study is one that takes into account that becoming digitally competent is reliant on a number of underlying phenomena that may act in isolation but may also impact on each other. For this reason my study is informed by an interpretivist framework. Such a framework presents the reality of the participants from their own views and follows the premise that knowledge is constructed not only by observable phenomena, but also by descriptions of people's intentions, beliefs, values and reasons, meaning making and self-understanding (Henning, Van Rensburg, & Smit, 2004). In such a framework the researcher looks for frames that shape the meaning that participants make and remains extremely sensitive to the role of context (Henning, et al., 2004). This is reiterated by Giddens (1984a), as he describes the prioritisation of the construction and negotiation of meaningful activity by interpretivists.

I used an interpretive theory, namely actor network theory (ANT), in my research to create an organisational framework in order to identify the phenomena that influenced the ways in which students came to be digitally competent. This framework allowed me to examine the ways in which the students made sense of the social world. ANT analyses challenge many assumptions underpinning certain educational conceptions of development, learning, agency, identity, knowledge and teaching. Such an analysis makes visible the rich assortment of things at play in educational events and how they are connected (Fenwick & Edwards, 2010).

1.6. Limitations of my study and positionality of the researcher

My study takes place at a High Educational Institution in Johannesburg, Gauteng, South Africa. I chose to focus on first year pre-service teaching students at this HEI. As identified in the literature, a number of factors such as race, gender, age, literacy levels, may hinder or enable a student's development of digital competence. I acknowledged these factors and chose to focus specifically on the factors of computer attitude and digital self-efficacy. There are a number of limitations to my study that should be noted.

Firstly, my study cannot be generalised to all higher education institutions elsewhere, as I discuss again in chapter three – in the transferability section 3.4.2. The students came from a number of different ethnic and population groups as well as speaking a variety of home languages. The students I selected for the phase two case studies were diverse in their digital competence skills. I focused on a mix of novice to advanced ICT users. I was limited by the availability and willingness of students to participate in my research.

My study took place in an HEI where the medium of instruction was English. The baseline digital competence test, as well as the course material was all in English. Phase two students comprised of two groups, 14 students who enrolled in 2013 and 14 students who enrolled in 2014. The interviews with the phase two students took place over a period of two years, 2013 and 2014. I saw each of the 28 students for an individual interview. Follow-up interviews were conducted with some of these students six months later.

One of the challenges that I encountered was the first year Digital Literacy course changed over the period of my study. In 2013 the course was run by a different course organiser than in 2014. This meant the focus of the course, its course material as well as the assessment practices were different over the two years. However, the students did not change and experienced the same barriers and enablers regardless of the course content and delivery.

In chapter three, I discuss my philosophical assumptions and the methodology I employed. My research was a mixed methods approach with a balance of both quantitative and qualitative data collected.

All researchers are positioned by age, gender, race, class, nationality, institutional affiliation, historical-personal circumstance, and intellectual predisposition (Chiseri-Strater, 1996). The reconstructing of insider/outsider status in terms of one's positionality in respect of education, class, race, gender, culture and other factors, offer us better tools for understanding

the dynamics of researching within and across one's culture. Since bias remains a naturally occurring human characteristic, *positionality* is often used as an exploration of the investigator's reflection on one's own placement within the many contexts, layers, power structures, identities, and subjectivities of the viewpoint (England, 1994; Merriam et al., 2001; Rose, 1997). Positionality allows for a narrative placement for researcher objectivity and subjectivity whereby the researcher is situated within the many aspects of perspective and positionality (Lave & Wenger, 1991). This often serves to inform a research study rather than to invalidate it as biased or contaminated by personal perspectives and social or political viewpoints. I am a white, middle class female who grew up in the apartheid era. I went to a co-educational school in the Northern suburbs. I completed a four year Bachelor of Primary Education (B Ed) degree at Wits in 1994. I became involved in computer education, as it was then known, when I taught at a Future Kids Computer School in the afternoons and on weekends. I then ran the computer centre at an East Rand primary school for 2 years. This involved teaching Grade 0 to Grade 7 pupils basic computer skills. Subsequently I moved to the HEI, where I taught diploma and degree pre-teaching students basic computer literacy skills while completing my Postgraduate Degree in Tertiary Education at Honours level. I went on to complete my Masters in Education (M Ed) while running the first year course.

In 2009 the Minister of Education in Limpopo made a bold move to re-educate all its Foundation Phase teachers[2] (Newspaper article in Appendix D). These 240 teachers joined the HEI and first year numbers swelled in 2009 to 740. This placed a strain on the available resources, and most importantly computer access. A new lab was built to accommodate these students, but for their first year, access was limited. It was during this time that I realised that not all students had had prior access to and skills training with a computer or ICT device. Discussions regarding the phasing out of the first year Computer Literacy course began with me advising for its retention. Some staff members felt that *everyone* in this *day and age* knew how to use a computer and there was no longer a need for a basic JIC ICT course. Following on from my Masters research into the barriers that first year students faced when accessing digital devices, I was prompted to further my investigations into this area. I aimed to look at the basic ICT skill levels that first year students possessed when entering the institution and the impact that identified factors could have on their development of a desired level of digital competence.

[2] http://152.111.1.87/argief/berigte/citypress/2009/02/02/CP/6/prteachers.html

During that year I became a junior researcher on the PanAf research agenda on the pedagogical integration of ICTs. This research project looked at the effective use of ICTs in teaching in 12 African countries' primary schools. It was interesting to analyse the difference between 'teaching computers' versus 'teaching through computers'. My view that teachers needed to possess an adequate ability to use ICTs themselves was further heightened by my involvement with this project. The only way that we can properly prepare our teachers of the future is to ensure they receive adequate training at the HEI at which they study. In order to facilitate this, the institution they are studying at needs to establish what digital competence skills the students currently possess, what they will need to operate effectively in a teaching position, and ultimately identify and alleviate any barriers that they may experience in the realisation of this.

1.7. Importance of my study

I intend for my findings to contribute to the research that Czerniewicz and colleagues from the University of Cape Town (UCT) have conducted into ICTs and their use in South African HEIs. These include studies into how ICTs can be used to address teaching and learning challenges in South Africa (Czerniewicz & Brown, 2005c; Jaffer, Ng'ambi, & Czerniewicz, 2007). Other studies have also investigated the barriers that both academics and students may face when using ICTs (Brown & Czerniewicz, 2005; Seymour & Fourie, 2010) as well as the issue of access and use (Brown & Czerniewicz, 2007; Czerniewicz & Brown, 2005a, 2005b; Czerniewicz, Brown, Lee Pan, & Moyo, 2009).

The role of gender and access is also highlighted in research (Czerniewicz & Brown, 2014). While the use of ICTs as agents of change has been investigated (Czerniewicz, 2004; Czerniewicz, et al., 2005), this was not a focus in my study. There are studies looking into the notion of digital natives and digital immigrants in South Africa (Brown & Czerniewicz, 2010). Findings from some studies have shown that the notion of access is a more discerning factor than that of age (Brown & Czerniewicz, 2010; Czerniewicz & Brown, 2010). A Canadian study in 2011 suggests that the popular view that generation or age impacts on the successful development of digital literacy is not actually an issue. Rather familiarity, cost and immediacy are more pertinent factors (Bullen, Morgan, & Qayyum, 2011). I contribute to research on the role that age may or may not impact on an individual's development of digital competence.

While Czerniewicz and her colleagues at UCT have conducted numerous studies with regards the use of ICTs in South African HEIs, my study provides detailed findings on the impact of attitude and self-efficacy in the development of digital competence in first year pre-service teaching students. I describe the students, their barriers, enablers and digital competence levels in great detail. I provide an account of first year pre-service teaching students unique networks of learning to become digitally competent. While I do not propose that my research findings can be generalised to other situations, certain findings are relevant to others' research and situations. I intend for the knowledge gained from the findings in my study to be related to other contexts. My research findings better inform practitioners, namely course designers and presenters, at the HEI when designing and teaching the compulsory first year ICT course.

1.8. Structure of the thesis

Chapter 1: Introduction

Chapter one provides an introduction to my study. In this chapter, I provide background on the first year pre-service teaching ICT course offered at the HEI. I discuss the JIT and JIC debate that dominated the division in which I taught prior to the outset of my study. I outline the purpose of my study, the research questions and the theoretical framework that I use. I present my four research questions that I use to answer the overarching research question: *What role do digital self-efficacy, computer attitude and other factors play in the development of digital competence in first year pre-service teachers at the HEI?* I also list the limitations of my study and argue for the importance of my research as a new contribution to the field of digital competence education.

Chapter 2: Review of the literature

In chapter two, I provide a survey of prior research conducted in the areas relevant to my thesis. This includes computer attitudes, digital self-efficacy, the development of digital competence and the barriers and enablers that individuals may encounter when engaging with ICTs. Digital divides identified in the literature are discussed. I focus specifically on literature pertaining to computer attitude and digital self-efficacy. I present the South African White Paper on eEducation which proposes a desired level of digital competence of pre-service teaching students graduating from higher education institutions. Finally I report on models of skill acquisition as well as the analytical framework, actor network theory, which I employ in this study.

Chapter 3: Methodology

In chapter three, I describe the research paradigms which guide my research, the methodology I employ as I identify the barriers that students face when accessing ICTs. I discuss the mixed methods research approach I use, i.e. a survey and multiple case study, and the research instruments I use i.e. a survey questionnaire, baseline digital competence test, attitude and self-efficacy scales and interviews. I conclude with a discussion of how I provide rigour in my research and conduct my research in an ethical manner.

Chapter 4: Analytical reasoning

In chapter four I detail the interpretivist theoretical framework underpinning my research. In addition to this I explain the actor network theory (ANT) approach that I use in my analysis of my research findings. My research is an original application of ANT as an analytical framework in a study that investigates the development of digital competence and the factors, phenomena or actors that may impact on this network of learning.

Chapter 5: Digital competence

In chapter five I recap on the literature definition of digital competence and construct a definition specific to my research population through an analysis of the students' responses in the online questionnaire. I provide information on the two first year ICT courses offered in 2013 and 2014. I analyse the baseline digital competence tests results and establish the current levels of digital competence of the first year pre-service teaching students as they enter the HEI. Research questions one and two are addressed in chapter five.

Chapter 6: Identifying factors impacting on the development of digital competence

The first year pre-service teaching students list barriers and enablers to their effective engagement with ICTs in their responses in the online questionnaire. The findings provide an answer to research question three.

Chapter 7: Computer Attitude and Digital Self-Efficacy and the development of digital competence

I continue my focus on the two sub questions of research question three in chapter seven. The two sub questions explore the phenomena of computer attitude and digital self-efficacy and their impact on a student's development of digital competence. I provide a detailed analysis of the students' responses in the Loyd and Gressard Computer Attitude Scale and Murphy Digital Self-efficacy Scale. I compare these results with the students' results in the

baseline test. I draw conclusions to whether there are any correlations in their attitude, belief in their own ability and performance in the baseline digital competence test.

Chapter 8: Coming to be digitally competent

In chapter eight, I describe the adult learners entering the HEI and their characteristics of learning. Qualitative data from the phase two interviews is presented and I discuss any commonalities in the students' accounts of their process of coming to be digitally competent. Research question four is answered in this chapter. The findings presented here demonstrate the complex and multifaceted process of coming to be digitally competent.

Chapter 9: Discussion and implications

I provide a summary of my main findings in chapter nine and conclude how these findings provide answers to my four research questions and my overarching research question. I provide a critical reflection of the research process I used. I discuss implications for future research and practice before concluding my thesis.

1.9. Conclusion

I begin this chapter by providing a background to my research, in addition to the purpose of this study. By providing a brief overview of my research process, I outline the research and present the research questions. These research questions underpin the importance of my study.

In the following chapter two I explore what theory and other research have to say about the process of coming to be digitally competent.

Chapter 2 - Review of the literature

In this literature review I provide an overview of the current research in the area of developing digital literacy. This includes a brief history of digital literacy as well as the assessment of digital literacy. I present a proposed definition of digital literacy or digital competence[3] relevant for my research. In the second section I summarise research that has been conducted with respect to the factors that may affect an individual's effective use of ICTs. Finally I investigate the two specific factors of computer attitude and digital self-efficacy which form the core focus of my research.

2.1. Computer literacy, information literacy and digital literacy

As I describe the ways in which first year pre-service teaching students develop digital competence in my study, it is necessary to first define what is meant by digital literacy. The term digital literacy is often bandied about in practice and in the literature. Many possible definitions exist and a precise definition that focuses on ability and skills without ignoring understanding is hard to find. **Computer literacy** is a vague term coined by Andrew Molnar in 1972 while he was the director of the Office of Computing Activities at the United States National Science Foundation. In an interview he defined it as the "basic skill in the use of computers, from the perspective of such skill being a necessary societal skill" (Aspray, 1991). This assertion that it is a necessary societal skill is quite forward thinking for 1972 when considering today's technological world which involves the much needed societal collaborative tools such as communicating via e-mail, using social networking tools such as wikis and blogs. Delving further into the first part of the definition – "basic skill in the use of computers," Molnar suggests that this basic skill implies understanding of the concepts, terminology and operations that relate to general computer use.

In his 30 year old paper, Noble pointed out that the purpose of all computer literacy training was not to make engineers or programmers of everyone; rather, its focus was on a minimal level of instruction that would introduce the masses to the ubiquitous computer and enable them to feel "comfortable," and to have " a sense of belonging in a computer-rich society" (Turkle, 1980, p. 1). He went on to ask what apparently convinced an entire population that something as vague and worthless as computer literacy was essential to their lives (Noble,

[3] In this section I discuss the history of digital literacy before I address the difference between digital literacy and digital competence on page 24.

1984). Even in 1982 we were told that teachers should be required to be computer literate before graduation and that knowledge of computers should be a criterion for employment (Morsund, 1982).

These quotes show that even when computers were introduced decades ago, the value in possessing a certain degree of ability or knowledge to use them effectively existed. A comment made by a first year pre-service teaching student in her responses to a question in the online questionnaire used in my research elucidates this; "*because I believe that being able to use a computer will make life much more easier for me at university level, since it is the mostly used device for information and to type assignments* (17 year old female). The notion that being digitally literate is an advantage in our current ubiquitous and rapidly developing technological world was a common thread in the students' responses to the question asking why they wanted to become digitally literate. The final two I share here relate specifically to the students' future careers as teachers; "*It will benefit me in the future in my teaching career"* (18 year old female). *"Because South Africa is lacking with people who have a high level of digital literacy, so I don't want to add to that number. I want to improve so that I can help the coming generation*" (18 year old male).

Over the past 20 years, models of computer literacy and **information literacy** started to merge. This process was fueled by the rapid growth of technology, and its increasing impact on society. Developing a single notion of literacy that demands fluency in both technology and information (Hoffman & Blake, 2003) became necessary. The term computer literacy came to be referred to as information literacy in the 1990s. Information literacy course proposals expanded to include skills in finding, evaluating, and utilising information in the information age, and prerequisites for such courses included familiarity with computers (Rush & White, 1994). The term information literacy accommodated web-based information sources. Although computer literacy and information literacy remained distinct, they clearly began to converge (Hoffman & Blake, 2003). Information literacy was defined as a set of abilities requiring individuals to recognise when information was needed and have the ability to locate, evaluate, and effectively use needed information (Association of College and Research Libraries, 2000). Individuals also needed to be able to transfer information freely, and to have instant access to information that would have been difficult or impossible to find previously. This information age was the period beginning around 1970 and was aptly

named due to the abundant publication, consumption and manipulation of information, especially by computers and computer networks.[4]

Although the concept of **digital literacy** was not invented by Gilster, the beginning of real discussion of the term was the publication of Paul Gilster's 1997 book *Digital Literacy* (Belshaw, 2011). Gilster defined digital literacy as "…the ability to understand and use information in multiple formats from a wide range of sources when it is presented via computers" (Gilster, 1997, p. 1). Digital literacy is the essential knowledge needed to function **independently** with computers. This includes being able to solve problems, adapt to new situations, keep information organised and communicate effectively with other computer literate people.[5] This ability to work independently is vital to developing some degree of digital literacy which implies a certain level of comfort using a computer and their associated programmes. A community of practice of digitally literate people is implied here. A community of practice (CoP) is a term first used in 1991 by theorists Jean Lave and Etienne Wenger to describe a group of people who share a concern or a passion for something they do, and learn how to do it better as they interact regularly (Wenger, 2001). A notion of CoP is further supported by Menchaca (1997) who indicated that creating access to computers means more than just providing hardware, software and Internet connections. Providing equitable access includes considering cultural and skill differences in designing interfaces and providing comfortable environments in which people can realise their own potential

Generally 'literate' (in the realm of books) indicates an individual who can read any arbitrary book in their native language, looking up new words as they are exposed to them. Likewise, an experienced computer user may consider the ability to self-teach (i.e. to learn arbitrary new programmes or tasks as they are encountered) to be central to digital literacy. The advent of social media has changed the nature of written communication. Digital literacy is simply another form of literacy, mastery of which was becoming necessary to be literate in a world that so heavily relied on computer technology (Hoffman & Blake, 2003). More recently, Rheingold expanded on the notion of *literacies* to include concepts such as critical information consumption, managed media attention or 'infotention'. He also speaks of ethical collaborative research, networked coproduction of knowledge, and digital citizenship.

[4] http://www.thefreedictionary.com/information+age
[5] www.virtualbill.net/qamain.html

These are not traditional literacies. Rather they are new social skills necessary for a digital *informationscape* (Rheingold, 2012).

ICT usage is ubiquitous. More people are using technologies around the world, for more time and for different purposes. The extensiveness of use is a result of the digitalisation of society in general, as many activities have a digital component. Exposure to digital tools supports the domains of work, learning, leisure, participation, socialisation, and consumerism. As society is becoming digitalised, the knowledge, attitudes and skills that are needed to be digitally competent are becoming diverse. Being digitally literate today is not restrained to the understanding of hardware and software devices (Ferrari, 2012). Being digitally literate implies the ability to understand media, as most media have been or are being digitalised. Individuals also need to be able to search and critically evaluate retrievable information. They communicate with others through a variety of digital tools and applications such as mobile phones and the Internet. All these abilities belong to different disciplines: media studies, information sciences; communication theories (Ferrari, 2012). A digitally literate individual is required to determine the nature and extent of information needed, as well as, the ability to access the needed information effectively and efficiently. He or she evaluates the information and its sources critically, and incorporates selected information into his or her knowledge base and value system. A digitally literate individual uses information effectively to accomplish a specific purpose, either individually or as a member of a group. Such an individual also understands the economic, legal and social issues surrounding the use of information. He or she accesses and uses information ethically and legally (Association of College and Research Libraries, 2000). Digital literacy is a natural product of the changing nature of literacy as people's information and communication behaviours changed with the evolution of technologies. The definition of digital literacy encompasses much more complex learning processes involving a combination of technical, procedural, cognitive, and socio-emotional skills (McMahon, 2014).

As pointed out by Erstad in 2010, the term digital literacy moved through three main phases. The mastery phase began in the 1960s and lasted until the mid-1980s. This phase saw technologies being accessed by professionals who knew programming languages. Digital interfaces became more user-friendly from the mid-1980s to the late-1990s. As a result, digital devices were made more accessible to the general public and this second application phase gave rise to mass certification schemes. Due to technologies becoming simpler and

more domesticated, they also became more necessary. Targeted courses were developed to answer to specific needs and many eLearning initiatives and digital literacy courses were designed, highlighting access and accessibility and tool-related operational skills as a basic competence. From the late 1990s, a third phase – the reflective phase recognised the need for critical and reflective skills in the use of technology (Erstad, 2010a).

The three terms; computer literacy, information literacy and digital literacy were used synonymously and interchangeably until an OECD project defined **digital competence** as more than just knowledge and skills. The report revealed digital competence involved the ability to meet complex demands, by drawing on and mobilising psychosocial resources, including skills and attitudes, in a particular context (Organisation for Economic Co-operation and Development (OECD), 2005). Ilomäki, Kantosalo and Lakkala, (2011) use the term digital competence to encompass digital literacy and information literacy in their paper defining digital competence. They point out that in the widest and most recent definitions, based on policy-related papers and reports, digital competence consists not only of digital skills but also social and emotional aspects for using and understanding digital devices. Digital competence is an evolving concept related to the development of technology as well as the political aims and expectations for citizenship in a knowledge society. It consists of a variety of skills and competences, and its scope is wide, covering media and communication, technology and computing, literacy, and information science (Ilomäki, et al., 2011). The European Commission defines digital competence as involving the confident and critical use of information society technology for work, leisure and communication. Digital competence is grounded on basic skills in ICT. This includes the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet (European Commission, 2010). Ilomäki and her team suggest that digital competence consists of firstly technical skills to use digital technologies, secondly, abilities to use digital technologies in a meaningful way for working, studying and for everyday life in general in various activities. They thirdly suggest that the term includes abilities to critically evaluate the digital technologies, and finally, motivation to participate in the digital culture (Ilomäki, et al., 2011).

In addition to the above discussion of what it means to be digitally competent, I include the possession of the essential knowledge and skills needed to function **independently** with digital devices in my understanding of digital competence. As Stewart documented, this

includes being able to solve problems, adapt to new situations, keep information organised and communicate effectively with other digitally literate people (Stewart, 2011). This ability to work independently is vital to developing some form of digital competence which implies a certain degree of comfort using digital devices and their associated programmes. Technology continues to shape our definition of digital competence. Portable and mobile devices are ubiquitous and changing our definitions of literacy. In wireless-enabled environments, laptop computers are used anywhere. Mobile phones are web-enabled and as a result, computing technology clearly mediates how we perceive our world. Concepts of digital competence grow with this new technology and encompass wider use of computing technology and its social prominence (Hoffman & Blake, 2003). Hence it is a definition that encompasses the effective and independent use of technological devices, not just computers.

From this point forward I refer to competent use of digital devices as **digital competence**. Digital competence is the set of knowledge, skills and attitudes needed today to be functional in a digital environment (Ferrari, 2012). Competence is defined as the state of having the knowledge, judgement, skills, energy, experience and motivation required to respond adequately to the demands of one's professional responsibilities (Roach, 1992). It is also defined as being able to demonstrate that the knowledge, values and skills learned can be integrated into practice (Carraccio, Wolfsthal, Englander, Ferentz, & Martin, 2002). A more elaborate definition and discussion of what digital competence embodies is presented in chapter five. While Belshaw (2012) defines literacy as the ability to read and write, we now have varied technologies that require us to read and write in different ways. As a result there is a need for multiple literacies. A skill is a controlled activity such as a physical action that an individual has learned to perform. Competences are collections of skills for a pre-defined purpose. Literacy focuses on the *breadth* of understanding of the technological world while competence is more concerned with *depth* of understanding and skills in a specific technical area (Belshaw, 2012).

2.1.1. Developing digital competence

What do we teach in ICT or digital competence courses? A traditional approach, covering office applications may not provide the first year pre-service teaching students with what they need. Course organisers need to ascertain student abilities in digital competence courses as the students may have already mastered certain content and skills (Hoffman & Blake, 2003). There are studies that have been conducted into best practices in the approaches to teaching

digital competence. An integrated approach which proposes the acquisition of skills in the context of a meaningful and relevant activity dominates the research (Aviram & Eshet-Alkalai, 2006; Lakkala, Ilomaki, & Kantosalo, 2011; Rodriguez Illera, 2004). It follows that pre-service teachers who are taught how to use ICTs through an integrated approach, will be better able to integrate ICTs in their own teaching. My research is not an analysis of the manner in which digital competence is taught at the HEI. Rather, it is an investigation into the phenomena that the first year pre-service teaching students encounter in the process of coming to be digitally competent. Competence acquisition in a digital era may be defined as a mindset, enabling the user to adapt to new requirements set by the evolving technologies (Coiro, Knobel, Lankshear, & Leu, 2008). I found it interesting that Coiro and colleagues propose that in order to become digitally competent, individuals should possess a set of established attitudes that embrace adapting to the rapidly advancing technological world around them.

Independence and adaptability when using digital devices is a recurring notion mentioned in digital competence research. According to Gee (1996) becoming fluent or native-like with technologies only happens when acquisition is embedded in social practice. This entails certain ways of talking about the tools, of holding certain beliefs and values about them, and socially interacting over them in certain ways. In other words, technologies need to be appropriated by users. Appropriation involves a specific way of interacting with technologies and requires specific attitudes. It necessitates understanding them and therefore holding specific knowledge about them. Finally it entails being able to use them and having specific skills (Ferrari, 2012). Attitudes and beliefs in ones' own ability when using digital devices is significant. In my research I investigated whether a positive computer attitude and strong belief in one's own digital self-efficacy may have affected the development of digital competence.

2.1.2. The Just-in-Time (JiT) versus Just-in-Case (JiC) debate

As stated above, individuals learn about the technology if they can relate it to their lives. Considering the balance between formal and informal acquisition with how we live our lives, informal acquisition of skills may well be the primary mode for learning about technology (Hoffman & Blake, 2003). As I mentioned in my introductory chapter, a departmental debate within the HEI had staff members arguing for and against a just-in-case (JiC) approach. Hoffman and Blake suggest that individuals acquire most of the skills **they** consider

meaningful on their own and point out most computing skills of value are learned informally (Hoffman & Blake, 2003). In place of formal education, skills are acquired by targeted training, such as Frequently Asked Questions (FAQs) and help desks. Acquisition of skills is just in time or on demand (Hoffman & Blake, 2003). Juxtaposing this, in a just-in-time (JiT) approach, skills are mastered as individuals encounter needing to use them. For example, an individual needs to send an email with an attachment for the first time. Employing a just-in-time approach, they could possibly ask a friend, use the application's built in help function, employ a trial and error approach or even conduct an Internet help search. The individual learns how to add an email attachment in the moment that they need this skill. Just-in-time proponents suggest that the individual will now remember this skill better than if they had been shown it in a formal learning scenario.

Congruent with researchers discussed previously in this chapter, Chase and Laufenberg detail a digitally competent user being able to **adapt** and **learn new** procedures through various means while using computers. As a result computer education should not be rote memorisation. Students should not be taught how to perform several specific common functions (e.g. open a file, save a file) in a very specific way, using one specific version of one specific programme. When faced with a different programme or a different version of the same programme they are confused or frightened by the differences from what they have learned. These students rely on paper notes for some computing tasks and need tremendous amounts of hand holding. While there are many interpretations and facets to digital competence, there is a strong consensus that it is essential for future success (Chase & Laufenberg, 2011). A 2009 OECD report found that digital competence is significant to academic achievement because digitally competent students are able to judge the credibility of information, as well as, integrate multiple forms of information. In addition, they obtain more frequent and better feedback, and engage in the most up-to-date research and thinking (OECD 2009, cited in (McMahon, 2014). However, studies have found that many students lack even basic skills such as Internet searching, despite a heavy reliance on these skills (Marupova & Vega Garcia, 2007).

The shift to more natural and intuitive interfaces is a step towards the integration of technologies in everyday life (Punie, 2005). Ferrari points out that such a shift does not mean that in the future there will be no need for learning how to use technology. For ease of use of digital devices, a certain series of skills on how to use tools, and a body of knowledge

related to these tools is required. These would be just-in-case skills. Just-in-case advocators suggest that individuals are not able to use digital devices effectively without some initial instruction in basic digital skills (Goveia & Soule, 2003). Ferrari points out that the move from a professional tool into an everyday appliance requires an understanding of the possibilities, consequences, and affordances of the device. As technologies evolve, so do the competences that are needed to use them (Ferrari, 2012). A significant number of the first year pre-service teaching students participating in my research reported that they were novice (8%) or beginner ICT users (34%). When asked why they wanted to improve their digital competence skills, 48% cited their inexperience with ICTs as a reason. This lack of previous experience was identified as a barrier to their effective use of ICTs by 24% of the surveyed students. As Gouveia and Soule propose, surely these novice and beginner students will benefit from initial training in basic digital skills rather than having to acquire skills on their own just-in-time?

Proposals for digital competence courses over the past three decades were shaped by available computing technology and its degree of integration into society. The flow of new technology: minicomputers to personal computers to the Internet, shaped what is considered standard knowledge. Today, portable and mobile digital devices promote the integration of computing technology into society. Digital competence has changed and skills are now taught on demand (Hoffman & Blake, 2003). I believe there is a place for a combination of the two methods. A just-in-case approach ensures that the students have enough basic skills and confidence to begin operating a digital device. A just-in time approach results in the skill holding more value for the student and as a result, a better retention rate.

2.1.3. Assessment of digital competence

After defining digital competence I contemplated how best to measure it and whether a coherent assessment procedure was in fact possible. Selecting a means to measure digital competence involved looking at the sub-disciplines of digital competence. As I identified the barriers and enablers the first year pre-service teaching students encountered when accessing digital devices in the process of becoming digitally competent, I needed to further investigate the skills that made up digital competence.

Most approaches to digital competence regard skills that are tool-dependent. Focus is on the practical abilities required to use a specific software or hardware. Although tool-dependent approaches become outdated in no time, they have the advantage of describing skills that are

specific and easily measurable (Ferrari, 2012). Analysing the range of competences related to digital competence requires an understanding of all these underlying aspects. New requisites for being functional in a digital environment, such as the ability to peruse hyperlinked texts have also emerged (Ferrari, 2012). I focused on four digital competence frameworks that provide a detailed breakdown of the necessary skills or abilities related to developing a holistic vision of what it means to be digitally competent.

Eshet-Alkalai, 2004, proposes a framework consisting of five types of literacy skills. These literacy skills are; photo-visual literacy, reproduction literacy, information literacy, branching literacy and socio-emotional literacy. He argues that this model covers most of the cognitive skills that individuals employ in digital environments and is considered to be one of the most complete and coherent models for digital literacy (Eshet-Alkalai, 2004). **Covello,** 2010, in his research on digital literacy assessment instruments tabulates the six sub-disciplines of digital literacy that he encountered. These skills are; visual literacy, computer literacy, media literacy, communication literacy, visual literacy, technology literacy. **The FutureLab handbook** was developed by a non-profit independent organisation that is interested in developing creative and innovative approaches to education, teaching and learning. The eight components of digital literacy that they identified are best illustrated by figure 1 below.



Figure 1: FutureLab's digital literacy components (Hague & Payton, 2010)

Authors of this FutureLab handbook, Hague and Payton state that developing digital literacy is about developing skills, knowledge and understanding in all of the above components in no particular order. **JISC and Mc Hardy** believe that digital literacies encompass a range of other capabilities represented below in the seven elements model in figure 2 below. Their Developing Digital Literacies programme set out across 2011 to 2013, to explore institutional approaches to digital competence development in universities and colleges (JISC & Mc Hardy, 2013).

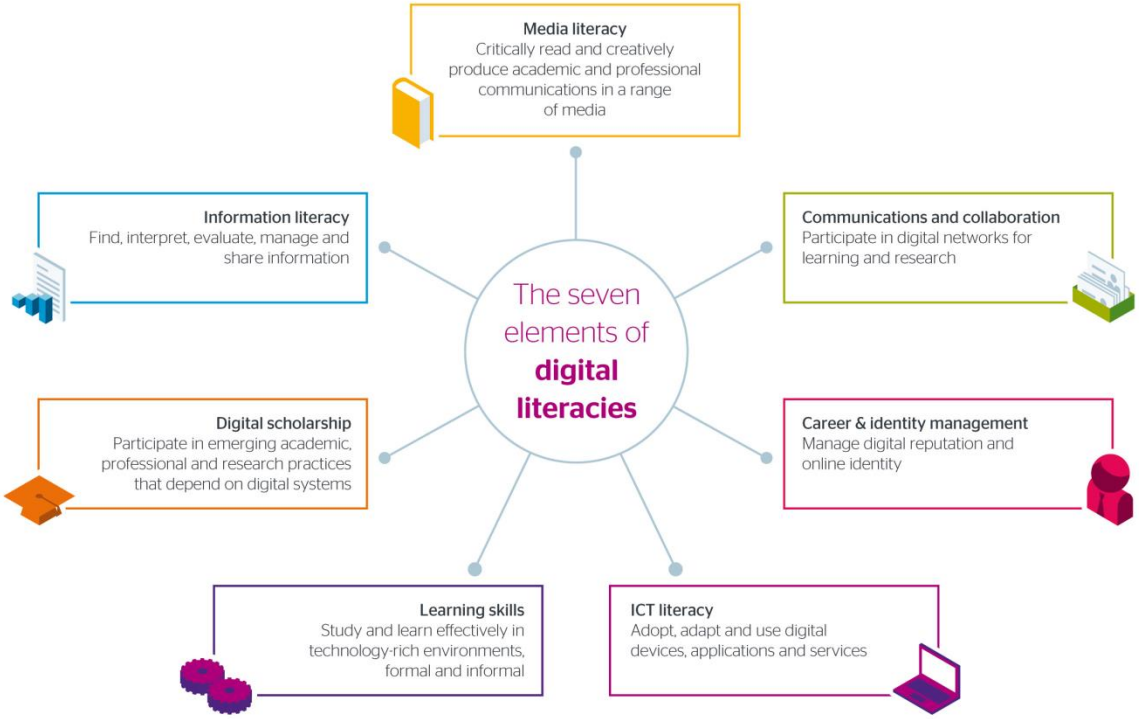


Figure 2: JISC and Mc Hardy's developing digital literacies programme (JISC & Mc Hardy, 2013)

I tabulated the above research findings with regards to the different components or literacies that make up digital competence in table 1 below. I illustrated commonalities between each framework through the use of colour shading. As can be seen in the table below, the functional ability to use a computer and its applications is just one small part of digital competence. There is currently a large amount of literature on the need to develop 21st Century Skills in learners. These skills are seen as necessary for individuals to cope in the ever-changing technological environment and workplace. Many variations on the necessary skills exist and the list of skills used here is the one defined by Cisco, Intel and Microsoft for their Assessment and Teaching of 21st Century Skills Project (Binkley et al., 2010).

Digital competence has been acknowledged as one of the eight key competences for lifelong learning by the European Union. Defined by the European Union as the confident, critical and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion and participation in society, it is a transversal key competence which enables acquiring other key competences such as language, mathematics, learning to learn and cultural awareness. It is related to many of the so-called 21st Century skills which should be acquired by all citizens, to ensure their active participation in society and the economy (Ferrari, 2012). I included these 21st century skills in the far right column of table 1 and it was interesting to see how they aligned with the digital competence skills and components identified by other researchers. The majority of frameworks are based on skills development and on the ability to use a specific set of tools and/or applications. As defined earlier on in this chapter, skills are only part of the learning domains included in digital competence. The ability to use specific tools or applications is just one of the several competence areas that need to be developed by users in order to function in a digital environment (Ferrari, 2012). For this reason, Ferrari suggests a balanced approach, where each of these competence areas is equally developed. She elaborates by suggesting that competences should not be centred on a tool-orientated perspective only.

Table 1 below emphasises that a good baseline digital competence test as well as a definition of digital competence needs to take many, if not all, of the detailed components or literacies into consideration when assessing an individual's digital competence level. However, digital competence assessments that focus only on functional skills are common. There are many sub-disciplines of digital competence and a wide variety of research perspectives into digital competence components evident in table 1 below. In chapter five, I use a revised version of table 1 to guide me in developing a definition of digital competence when answering research question one: *What are the first year pre-service teaching students' perceptions of digital competence?*

Table 1: A comparison of components of digital competence from various research views

Eshet-Alkalai's five literacy skills (2004)	Covello's six sub-disciplines of digital literacy (2010)	FutureLab's eight components of digital literacy (2010)	JISC and McHardy's seven elements of digital literacies (2013)	21st Century Skills (2010)
Photo-visual literacy The ability to intuitively read and understand instructions and messages that are displayed in a visual-graphical form	**Visual literacy** The ability to read, interpret and understand information presented in pictorial or graphic images. The ability to turn information of all types into pictures, graphics or forms that help communicate the information	**Creativity** The ability to actively explore and create digital media	**Media Literacy** Critically read and creatively produce academic and professional communications in a range of media	**Creativity and innovation** The ability to think creatively, work creatively with others and to implement innovations
Reproduction literacy The ability to create new meanings or new interpretations by combining pre-existing, independent shreds of information in any form of media – text, graphic, or sound	**Media literacy** A series of communication competencies, including the ability to access, analyse, evaluate and communicate information in a variety of forms, including print and non-print messages.			
Branching literacy The ability to remain orientated and avoid getting lost in hyperspace while navigating through complex knowledge domains, despite the intricate navigation paths they may take				
Information literacy The ability to make educated, smart, information assessments. The identification of false, irrelevant, or biased information. Critical thinking and questioning of information.	**Information literacy** Finding and locating sources, analysing and synthesising the material, evaluating the credibility of the source	**Critical thinking and evaluation** The ability to not only passively receive information or meaning but to also contribute to it, analyse it and shape it	**Information Literacy** Find, interpret, evaluate, manage and share information.	**Critical thinking, problem solving, decision making** The ability to reason effectively, use systems thinking, make judgements and decisions. The ability to solve problems
		The ability to find and select information The ability to find and select reliable and relevant information		**Information literacy** The ability to access and evaluate information. The ability to use and manage information

Eshet-Alkalai's five literacy skills (2004)	Covello's six sub-disciplines of digital literacy (2010)	FutureLab's eight components of digital literacy (2010)	JISC and McHardy's seven elements of digital literacies (2013)	21st Century Skills (2010)
	Communication literacy Ability to communicate effectively as individuals and work collaboratively in groups, using publishing technologies (word processor, database, spread-sheet, drawing tools), the Internet, as well as other electronic and telecommunication tools	**Effective communication** The knowledge, skills and understanding to choose the most appropriate communication tool for the task in hand and how to use it effectively	**Communication and Collaboration** Participate in digital networks for learning and research	**Communication** The ability to communicate clearly
Socio-emotional literacy The ability to not only share formal knowledge, but also to share emotions by means of digital communication, to avoid Internet traps and hoaxes. This is seen as the highest-level and most complex skill		**Collaboration** The ability to understand how to participate in shared spaces **E-safety** The ability to question own and others digital use and the ability to make considered choices		**Collaboration** The ability to collaborate with others
		Cultural and social understanding The ability to recognise that there are certain social, cultural and historical influences that shape one's understanding and learning		**Personal and social responsibility** **Citizenship** Cross cultural understanding and participation in a global society
	Computer literacy An understanding of how to use computers and application software for practical purposes	**Functional skills** The ability to functionally operate various digital devices	**ICT literacy** Adopt, adapt and use digital devices, applications and services	**ICT literacy** The ability to apply technology effectively. The use of technology as a tool to research, organise, evaluate and communicate information
	Technology literacy Computer skills and the ability to use computers and other technology to improve learning, productivity, and performance		**Learning skills** Study and learn effectively in technology-rich environments, formal and informal	**Learning to learn** Lifelong learning including learning self-reliance

Eshet-Alkalai's five literacy skills (2004)	Covello's six sub-disciplines of digital literacy (2010)	FutureLab's eight components of digital literacy (2010)	JISC and McHardy's seven elements of digital literacies (2013)	21st Century Skills (2010)
			Digital Scholarship Participate in emerging academic, professional and research practices that depend on digital systems	**Life and career skills** These include flexibility and adaptability, initiative and self-direction, social and cross-cultural skills. Also included are productivity and accountability and finally leadership and responsibility
			Career and identity management Manage digital reputation and online identity	

I included **Eshet-Alkalai's five literacy skills (2004)** model as it is considered to be one of the most complete and coherent models for digital literacy that covers most of the cognitive skills that individuals employ in digital environments (Aviram & Eshet-Alkalai, 2006; Capobianco, 2013; McMahon, 2014). It was developed in 2004 and is the oldest model that I incorporated. It is a holistic model that encompasses most of the dimensions of user activity in digital environments. It is also the model that has the most detailed description of socio-emotional literacy. Eshet-Alkalai details this as the highest level and most complex skill in his model. It is the ability to not only share found knowledge, but also to share emotions by means of digital communication, as well as, being able to avoid Internet traps and hoaxes. None of the other models I investigated mention this socio-emotional literacy. FutureLab is the only other model that has a similar skill, namely e-safety, which is the ability to question one's own and others digital use and the ability to make considered choices. Peter, a 20 year old male student, interviewed in phase two of my research project, mentioned lacking socio-emotional literacy as a barrier to his effectively working with ICTs with the statement: *"I would say the issue of learning the Internet, because some websites are not trustworthy and they could send a virus, or something like that, they could send you spam. So I think the Internet and getting some websites that aren't trustworthy, you want to make sure you can trust the information."* Communication skills are not detailed by Eshet-Alkalai, yet the other authors mention it as the ability to communicate effectively and participate in digital networks. Eshet-Alkalai is also the only author I reviewed not to mention having a functional digital ability in his list of literacy skills. Sixty-nine percent of the students who participated in my research described possessing a functional ability to use

ICT devices as what they understood being digitally literate to mean. An 18 year old female described digital literacy as *"having the ability to use technology and the Internet and being able to use it well enough to understand its functions, to type, do research, etc."* Due to the lack of detail in these two areas in Eshet-Alkalai's literacy skills, I explored additional models of digital literacy. The other three are more recent, Covello's six sub-disciplines of digital literacy and FutureLab's eight components of digital literacy were developed in 2010. JISC and McHardy's seven elements of digital literacies is the most recent model, developed in 2013.

Covello's six sub-disciplines of digital literacy (2010) were developed in response to his research on digital literacy instruments. Interestingly he splits functional skills into two separate sub-disciplines: computer literacy and technology literacy. He states that computer literacy is an understanding of how to use computers and their application for practical purposes. As mentioned above, the majority of the first year pre-service teaching students participating in my research indicated understanding being digitally literate to be the same as Covello's computer literacy – that is, using ICT devices for practical purposes, such as completing assignments. Eighty-three percent of the students indicated wanting to improve their digital skills. A 20 year old female explained that *"I answered yes because I believe that once I am computer literate or advanced, it will make my transition to varsity [university] more easier as most of the work done in varsity is typed, printed and then handed in."* Covello's second sub-discipline, technology literacy, builds on computer literacy. It incorporates computer skills and is the ability to use computers and other technology to improve learning, productivity and performance. The students wanted to improve their digital literacy skills as they felt it would do just this – improve their learning, productivity and performance. Of the students who answered yes to improving their digital literacy skills, 19%, mentioned it making their lives easier. I grouped Covello's two sub-disciplines, computer literacy and technology literacy, together as a functional skill in table 1 above. Both sub-disciplines encompass the ability to functionally operate various digital devices consistent with this competence identified by other researchers.

FutureLab's component of functional skills is the ability to functionally operate various digital devices. The **FutureLab handbook** was developed in 2010 by a non-profit independent organisation interested in developing creative and innovative approaches to education, teaching and learning (Hague & Payton, 2010). Developing skills, knowledge and

understanding in all of the eight identified components constitutes developing digital competence. Common across all the models I investigated was information literacy. FutureLab's model is closely related to 21st Century skills as it splits information literacy into two components. Firstly, the ability to critically think and evaluate information, secondly possessing the ability to find and select relevant and reliable information. 21st Century skills are the skills students need to develop in order to function effectively in the 21st Century. There is a move away from just being able to read, write and do arithmetic. Currently there is a large amount of literature on the need to develop 21st Century skills in learners. These skills are seen as necessary for individuals to cope in the ever-changing technological environment and workplace. The list of skills in table 1 above are defined by Cisco, Intel and Microsoft for their Assessment and Teaching of 21st Century Skills Project (Binkley, et al., 2010). The Partnership for 21st Century Skills Framework (2006) and www.p21.org provide a comprehensive baseline as P21's conceptualisation of 21st Century skills is well detailed and widely adopted. Ten 21st Century skills are identified and two of these relate closely to FutureLab's information literacy skills mentioned above. A necessary 21st Century skill is critical thinking, problem solving and decision making, defined as the ability to reason effectively, use systems thinking, to make judgements and decisions, in addition to an ability to solve problems. I linked this to FutureLab's critical thinking and evaluation ability in table 1 above. The 21st Century skill of information literacy is the ability to assess and evaluate information. This competence of using and managing information is evident in all the other models.

JISC and Mc Hardy believe that digital competence encompasses a range of other capabilities in their seven elements model. They are the only authors to link communication and collaboration together as one element. They define this skill as participating in digital networks for learning and research. None of the students I surveyed identified collaboration as having anything to do with being digital competent. Four percent of the students mentioned a communication aspect. A 29 year old female stated that digital literacy was *"being able to communicate using digital communication and networking."* Similarly, a 47 year old female identified it as knowing "*how to communicate with other people using a media device."* What interested me most in JISC and Mc Hardy's model was the emphasis on digital scholarship and career and identity management. These are two elements not identified and discussed by the other authors. Digital scholarship is the ability to participate in emerging academic, professional and research practices that depend on digital systems.

Career and identity management is the ability to manage one's digital reputation and online identity. I identified a link between these two and the 21st Century skill of life and career skills which include flexibility and adaptability, initiative and self-direction, social and cross-cultural skills. Also included are productivity and accountability and finally leadership and responsibility. Three of the students I surveyed mentioned that digital literacy had something to do with career skills, such as *"being able to use most programmes on a computer to aid you in your career and to communicate with others"* (20 year old male).

All of the models identify the component of online skills. Twelve percent of the surveyed students identified online skills as the second most important part of being digital literate. In table 1, I grouped Eshet-Alkalai's three literacy skills, photo-visual literacy, reproduction literacy and branching literacy in this overall category of online skills. Covello identifies visual literacy and media literacy, while Futurelab's component of creativity can be classified as an online skill. Similar to Covello, JISC and Mc Hardy detail an element of media literacy. The online skill category is closely tied to the 21st Century skill of creativity and innovation which is the ability to think creatively, work creatively with others and to implement innovations. While the 21st Century skills list is not specifically developed for the assessment of digital literacy, I felt that the list of skills was useful in developing a definition of digital competence because they aligned with the digital literacy skills and competencies identified by other researchers.

21st Century skills researchers, Binkley et al. view ICT literacy as the ability to apply technology effectively. Using technology as a tool to research, organise, evaluate and communicate information is promoted. I linked this ICT literacy to the functional skills detailed by the other authors as it specifically details the ability to functionally operate digital devices and use them as tools. I used components in the above models in table 1 to draw up a comprehensive table 15 in chapter five. I relied on table 15 in section 5.4. when I analysed the first year pre-service teaching students' perceptions of what it meant to be digitally competent. Table 2 below provides clarity on the outline of each component of each researcher's model already detailed in table 1 above and describes how I linked it to my coding categories. In table 2 I also outline the **key elements** of each model of digital competence discussed above and also illustrate which categories I linked together and used in my coding of the students' definitions of digital competence in table 16. I provide justifications for each coding element in section 5.4.

Table 2: A comparison of components of digital competence from various research views with my research coding

Coding of surveyed students' responses of definition of digital literacy	Eshet-Alkalai's five literacy skills (2004)	Covello's six sub-disciplines of digital literacy (2010)	Futurelab's eight components of digital literacy (2010)	JISC and Mc Hardy's seven elements of digital literacies (2013)	21st Century Skills (2010)
Online Skills	Photo-visual literacy	Visual literacy	Creativity	Media literacy	Creativity and innovation
	Reproduction literacy	Media literacy			
	Branching literacy				
Information Skills	Information literacy	Information literacy	Critical thinking and evaluation The ability to find and select information	Information literacy	Critical thinking, problem solving and decision making
					Information literacy
Communication Literacy Skills		Communication literacy	Effective communication	Communication and collaboration	Communication
Collaboration Skills	Socio-emotional literacy		Collaboration		Collaboration
			E-safety		Personal and social responsibility
			Cultural and social understanding		Citizenship
Functional Skills		Computer literacy	Functional skills	ICT literacy	ICT literacy
		Technology literacy		Learning skills	Learning to learn
Career Skills				Digital scholarship	Life and career skills
				Career and identity management	

A simpler view of technology literacy is proposed by the Computer Science and Telecommunications Board. This model is built around three broad strands. Foundational knowledge is an understanding of the underlying concepts of technology such as the fundamental principles of computers, networks and the Internet. Contemporary skills include the ability to use current hardware and software to perform useful functions. Critical thinking ability is a set of higher-order thinking and reasoning skills required for understanding and solving problems as they arise in modern technological systems (Haber, 2011). This model is not confined to the computer and is made up of multiple integrated knowledge, skills and abilities.



Figure 3: Digital literacy framework (Haber, 2011)

I illustrate through the above discussion of the four approaches presented in table 1, 21st Century skills, and the Computer Science and Telecommunications Board's technology literacy framework that there are many opinions as to what skills need to be developed before an individual can be classified as digitally competent. Selecting and administering a test that assesses these skills was more complex than I initially thought and entailed a research project in itself. On returning to the literature to explore best practices in digital competence assessment, I encountered conflicting views. Some researchers indicate that linear or multiple choice questions (MCQs) are the best method to assess key components of digital competence and the vital elements of an individual's technological abilities (Haber, 2012). Other researchers also call for some form of practical or simulation assessment (O'Connor,

Radcliff, & Gedeon, 2001; Pereira et al., 2009). The majority of the online tests available are multiple choice tests.

2.2. 'Divides' identified in the literature

The National Planning Commission Diagnostic Report stated that South Africa is a divided society where opportunity continues to be defined by race, gender, class, geographical location and linguistic background (National Planning Commission, 2011). In this section I explore the notion of divides identified in the literature as impacting on an individual's access to and effective use of ICTs. In 1984, Noble noted limitations that included lack of access to equipment as well as the enormous problems of untrained teachers, inadequate courseware, insufficient funds, and the wide disparity of access between rich and poor school districts (Noble, 1984). More than thirty years on, we have many of the same barriers. There is a wide variety of literature available in the area of the socio-economic, human, digital and physical barriers that students face when accessing ICTs. As a result of these barriers, there is a divide that exists between the 'haves' and the 'have nots'.

The **digital divide** is a key term that consistently arises throughout the literature. It came into regular use in the mid-1990s and is described as the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access ICTs and their use of the Internet for a wide range of activities (Irving, Klegar-Levy, Everette, Reynolds, & Lader, 1999; Organisation for Economic Co-operation and Development (OECD), 2001). Molnar argued in 2003, that new types of digital divides had emerged that went beyond access (Molnar, 2003). There are not only the *haves* and the *have-nots.* Livingstone and Helsper, propose a continuum of use, which spreads from the non-use of Internet to low and more frequent use. Only after an initial focus on access, and then use, did a third subsequent perspective of the digital divide move towards competence (Livingstone & Helsper, 2007). Erstad argued that digital inclusion depends more on knowledge and skills than on access and use (Erstad, 2010b).

2.2.1. Physical access

The initial description of the digital divide is a neutral one, with a lot of emphasis placed on physical access. It was thought that the main reason a troubling gap existed between the haves and the have nots was a socioeconomic one. However, it appears that there is not only inequality in gaining access to a computer terminal or hardware, but also inequality in the individual's ability to use the technology effectively and fully. The mere presence of ICTs

does not guarantee that they will be used. Angel, a 19 year old, female participating in my research reported that although they had computers at their high school, they were not allowed to use them. Lani, an 18 year old African female said that *"my school had computers, but then they ended up getting stolen."* It became evident that the division between students successfully using ICTs and those who did not, or could not, was a complex one and arguably many other factors came into play.

The digital divide has long been explained from the standpoint of having material or physical access to computers and the Internet. Despite statistically improved access to ICTs in most places of the world, the emphasis has, in recent years, moved to other factors which also seem to have significant influence on the digital divide (Gudmundsdottir, 2008). While it is generally accepted that such a divide does exist, Castells in his 1999 discussion paper for the United Nations Research Institute for Social Development, distinguishes between techno-elites and neo-luddites, more commonly known as people who resist new technologies. Neo-luddites view the use of information technology as a "tool for renewed exploitation, destruction of jobs, environmental degradation and the invasion of privacy" (Castells, 1999:1). The techno-elite group is characteristically more globally connected. Castells finds that a polarisation exists, around those who have IT skills -- the *IT rich* and those who do not – the *IT poor*. Castells advocates that our new world of globalisation as well as the information technology revolution is nothing more than a "warmed up version of capitalist ideology" (Castells, 1999:1).

Conceding that information technology is not the cause of the changes that we are currently living through and that without any new ICTs, none of what has and is changing our lives would be possible, he goes on to explain that the world "is organised around telecommunicated networks of computers at the heart of information systems and communication processes and that the entire realm of human activity depends on the power of information" (Castells, 1999:2). Individuals who are excluded from accessing this information either due to social reasons or inequality, are seriously disadvantaged. Compaine (2001) on the other hand argues that the digital divide is only a perceived gap. According to him such technological gaps are relatively temporary and should soon disappear as knowledge of ICTs will become less important as the technology becomes smarter and easier to use. It follows that in the future, individuals will not need high technological skills to access the Internet and perform necessary tasks on a computer. This can be seen in the

infiltration of mobile phones into the lives of both young and old. Individuals have learnt how to use mobile phones effectively out of necessity when initially they had no knowledge of such a technology. Compaine argues against spending substantial amounts of money on bridging the digital divide. This is in direct contrast to what South Africa is doing in schools at present (Compaine, 2001).

Speaking at an IT Charity event in April 2008, Lindiwe Mabuza, the High Commissioner of South Africa in The United Kingdom, commented that issues surrounding access to and skills in information technology were major contributors to economic and social inequality in South Africa. Her strongly worded address stated that "if South African children do not have [access to] this technology, then the past inequalities of apartheid will continue and that cannot be allowed to happen," and that "in poor communities of developing countries, the idea of touching, let alone using, a computer would be like a child taking the space shuttle to school every day" (Donoghue, 2008). The Deputy Minister of Communications, Dina Pule, advised in September 2009 that a Presidential Priority Project in the form of the Presidential National Commission (PNC) on Information Society and Development (ISAD) had been established in order to bring together stakeholders to address the challenges of bridging the digital divide. The troubled Gauteng on Line[6] project in the Gauteng province and the Khanya Project[7] in the Western Cape and the Connectivity project in the Northern Cape Province are two examples of the South African government trying to lessen the digital divide.

2.2.2. Age divide

Besides the obvious divide between those who have physical access to computers, relevant instruction and those who do not, Marc Prensky proposes a divide between *digital natives* and *digital immigrants*. Having written numerous books and articles on the issue of digital natives and digital immigrants – both terms which he coined, Prensky proposes the following definitions. Digital natives are people for whom digital technologies already existed when they were born, and hence have grown up with digital technology such as computers, the Internet, mobile phones and MP3s. These students are all 'native speakers' of the digital language of ICTs. Juxtaposed to these students are the older digital immigrants who while learning to adapt to the environment, retain their 'accent', or foot in the past (Prensky, 2001).

[6] www.gssc.gpg.gov.za
[7] www.khanya.co.za

In a Business Day report, the MD of Pearson education, Steven Naude, proposes that the biggest challenge in South African education today is bridging the divide between those born into a digital world and those who were not. He continues with the claim that research and experience have shown that traditional computer-based education has not been very successful in dealing with the challenges of higher education in South Africa. This is partly because many students are digital natives – individuals who have never not known a digital world, while their lecturers are digital immigrants – individuals not born into the digital world, but fascinated by new technology and willing to adapt to using it (Naidoo, 2005).

However, two groups of ICT users exist – those who are adept at using ICTs and those who are not. Whether these two groups can be clearly distinguished according to the year they were born, as Prensky proposes, is for me a contentious issue. Within the South African context, with its legacy of unequal education opportunities, these two groups of digital natives and digital immigrants may arise due to a number of other factors besides the one of age. Other factors to bear in mind include socio-economics, locality, language, gender, culture, race – as well as other aspects which will be explored in more depth in my research.

Generation Y is the name given to the group of people born between 1980 and 2000 (Naidoo, 2005). This is consistent with Prensky's digital natives who are typical of this Generation Y group having grown up in a time during which the Internet caused great change to all traditional media. The Internet was first used by the general public in 1988 and Generation Y individuals grew up surrounded by blogging tools, social networking and instant messaging. Alternatively referred to as the *Millennials*, this group displays ambition, confidence, optimism and a capacity for high-level co-operative work (Strauss and Howe, 2000). Junco and Mastrodicasa (2007), expanded on the generation theory work of Strauss and Howe with the view that this Millennial Generation presents unique challenges to tertiary institutions as they have never known a world without pervasive computer and communications technologies. One could assume that current technologies isolate students from each other as they spend so much time online, in front of a computer screen, rather than face-to-face with their peers. The results of studies that Junco and Mastrodicasa (2007), conducted prove the contrary. They report significantly *higher* levels of interaction with faculty—as well as higher expectations that they will have such interactions—and greater comfort communicating with others (albeit *not* fact-to-face). It is also proposed that Millennial students devote such a large amount of time to the use of technology that through this

constant use of the technology throughout their developing years has rewired their brains to allow effective multitasking (Prensky, 2001). Prensky argues that the brain's neuroplasticity allows the brain to adapt to the environment that it is in, so in a technology-infused environment the brain will adapt to better use the *tools* that are available in that environment.

Koutropoulos (2011) in his paper, *Digital Natives: Ten Years After*, criticises Prensky and other researchers for their overgeneralisations of digital natives. When critics suggested that context matters and that these assumptions were not universal, Prensky's (2003) rebuttal included technological buzz words and no hint of pedagogy. He proposed that he expects his observations hold true in the US, Japan, Korea and much of the rest of the world. Koutropoulos states that the main issue with Prensky's overgeneralisation of digital natives is the lack of detail about their socioeconomic status. He questions how the digital natives' socioeconomic status and their subsequent access to the technology that they have become skilled masters of can be ignored.

Many articles have been written suggesting best teaching practice for these digital natives. According to Prensky, key characteristics of digital natives include being creators rather than passive users. These individuals are more likely to create their own content and share their opinions online. As a result they may possess multiple online identities. Digital natives are more inclined to a culture of sharing, believing that they not only have a right to speak but also to be heard. Such individuals possess different information processing habits to the digital immigrants as they are more likely to 'graze' headlines than read the full article, whereas the digital immigrant is inclined to print out the article and read it in a linear logical manner. Digital natives learn through browsing and wrestling with large amounts of instantaneously available information and as a result they develop good multitasking skills. Junco and Mastrodicasa offer a number of practical recommendations as to what teaching methods best reach students who prefer to spend their time in front of a screen instead of a book or a lecturer. They recommend course presenters now require different skill sets than they needed to teach earlier generations. As a result of the 'wired' world in which they grew up, these students are less able to pay attention for long periods of time. They prefer hands-on learning and crave interaction with their peers or instructors. Recommendations include; integrating interaction either in person or online into courses. Opportunities for students to capitalise on their strengths in experiential learning should be provided as they prefer to arrive at their own knowledge. Students are motivated to learn if they have a sense of shared

ownership of their learning. The students are also able to multitask, so assignments and classroom tasks that allow for this should be provided. Provide help with assisting them understand issues of intellectual property and plagiarism by reviewing how to use and cite sources appropriately. These students will rarely use the library and need to be taught how to identify legitimate articles, research and information on the Internet. The focus of technology should be to meet the ultimate goal of enhanced interaction, bearing in mind their short attention span.

However, does a large easily identifiable group that can be called digital natives in fact exist? Even Prensky acknowledges in his recent 2010 writings that by virtue of being born in the digital age, students are digital natives by definition only. He concedes that this does not mean they were taught everything about ICTs, or that they learned on their own (Prensky, 2010). While the digital native was seen to be clearly superior, Garcia & Qin (2007) investigated the differences between 280 older and younger university students at Northern Arizona University. Their study showed that older students were more likely to change their approach to learning, whereas the digital native students were the least likely to change their approach to learning (Garcia & Qin, 2007).

In the South African context the words 'native' and 'immigrant' have the opposite meaning from what Prensky (2001a) describes within his American frame of reference (Czerniewicz & Brown, 2010). In South Africa, due to its colonial and apartheid past, the immigrant or the coloniser, may be seen as the forward thinker, while the native is seen as the one who is less advanced. Digital native, as a term, according to many, including Brown & Czerniwicz, is an 'othering' concept. Individuals who fall into one category, whatever the connotation and the qualities implied, cannot exhibit characteristics of the other category that they are not members of. This is problematic because there is an implied power relation, and superiority, attached to those particular sets of skills and dispositions of the digital native (Koutropoulos, 2011).

Sayayo, Santos, Gonzalez, Arenas and Lopez (2007), conducted research into whether older people learn differently and although they focused predominantly on the elderly, they highlight the importance of peer support as the scaffolding mechanism for the older digital immigrant's entry into the technological learning environment. As mentioned previously in section 2.1., Community of Practice (CoP) is a concept that refers to the process of social learning that individuals experience as well as the shared socio-cultural practices that emerge

and evolve when a group of people interact in a group or community. Lave attempted to explain and describe learning that occurs in apprenticeship situations. Later, Lave, in collaboration with Etienne Wenger originated the concept legitimate peripheral participation. It is a description of how the newcomers become experienced members and eventually old timers of a community of practice. N*ewcomers* or *novices* enter a community of practice and attempt to acquire the socio-cultural practices of that community. Through working in groups, these students are enabled to discover new things by sharing their knowledge with their peers. Lave and Wenger argue that people operate and exist within communities of practice, and that it is by entering these communities of practice that people learn. For people to achieve mastery of skill and knowledge within a community of practice, novice learners adopt the socio-cultural norms of a community. Lave and Wenger argue that in this context, learning is an integral part of practice. This implies a relationship between learning, the artefacts of practice[8], and the social relationships that create a community.

Eurostat data in 2010 shows that there are several categories of the population with low digital skills, looking specifically at computer skills and Internet skills. These are the elderly, the inactive, and the uneducated (Union, 2010). Even the youngest generations, albeit being known as digital natives by Prensky, do not necessarily score highly in terms of digital competence in international tests (Ferrari, 2012). Koutropoulos (2011) cautions against naming this generation the Digital/Net/Google Generation because these terms have the potential of keeping this group of students from realising personal growth by assuming that they have already grown in areas that they so clearly have not. As mentioned earlier in chapter one, Czerniewicz, 2010, is against making assumptions that all students are digitally competent. Findings from her studies have shown that the notion of access is a more discerning factor than that of age (Brown & Czerniewicz, 2010; Czerniewicz & Brown, 2010).

2.3. Factors that either enable or inhibit effective use of ICTs

"*I am not used to it. I do not have it at home*" (19 year old male first year pre-service teaching student).

Throughout the literature it is evident that the assumed barriers a student encounters when accessing ICTs are more numerous and complex than initially identified. These barriers also

[8] Man-made tools

appear to be interrelated and a student may experience a number of different barriers simultaneously. Darkenwald and Merriam (1982), identify four general categories of learning barriers in adult learning. These proposed barriers are *situational barriers* which relate to an individual's life context at a particular time, for example, cost, lack of transport, lack of childcare, lack of time as well as geographical isolation. *Institutional barriers* include inconvenient schedules, lack of appropriate courses as well as institutional policies and practices that impose inconvenience, confusion or frustration on adult learners. *Informational barriers* arise when the institution fails to communicate information on learning opportunities to adults. *Psychological barriers* are individually held beliefs, values, attitudes or perceptions that inhibit participation in learning activities. The student may feel that he or she is too old to learn or is afraid to use ICTs.

There are numerous studies involving ICTs and pre-service teaching students. Studies on the possible barriers and possible enablers of ICT integration into pre-service teacher education programmes in Turkey have been conducted by Goktas, Yildirim and Yildirim in 2009. Brown and Czerniewicz also conducted numerous studies on the barriers that higher education students in South Africa face. Increasing attention is given to young people's interaction with digital cultures and it is easy to assume that they are digitally competent. It is often alleged that having grown up with technology, young individuals have a wealth of digital technology skills that far surpass those of their digitally immigrant parents and teachers. The youth are confident in using a wide range of technologies and often turn to the Internet for finding information. They appear to learn to operate unfamiliar hardware or software very quickly and may take on the role of teaching adults how to use ICTs and the Internet (Hague & Payton, 2010). However, 16% the first year pre-service teaching students who completed my online questionnaire stated that they relied on a family member to teach them how to become digitally competent. Of this 16%, over a quarter, 28% said that the family member was a parent.

Hague and Payton (2010) point out that this innate ability to operate digital devices is not evenly spread amongst all young individuals. It is instead affected by issues of class, race, gender and nationality. Researchers point to a 'participation gap' which signals unequal access to the opportunities, skills and experiences that will prepare students for life in the 21st century. In addition, teachers are increasingly reporting that many young individuals are not as knowledgeable and savvy as they appear to be. Their confidence in their use of

technology can be misleading (Hague & Payton, 2010). Table 3 below reviews the above mentioned factors in addition to others identified in the literature as impacting negatively on an individual's successful interaction with ICTs. The first year pre-service teaching students identified barriers that are not accounted for in this list and I provide more detail on these unique factors in chapter six.

Table 3: Factors identified in the literature affecting the effective use of ICTs

Factor	Brief overview
Physical	Access or lack thereof to actual ICT hardware such as a computer, cell phone, mobile phone, laptop etc.
Digital	Access or lack thereof to relevant online content or software
Human	Access or lack thereof to skilled human resources such as a skilled facilitator
Socio-economic	Refers to the economic resources that one has
Age	Older individuals have not grown up in a digital, technological world and this may impact on their current ICT acceptance and usage
Language	Access or lack thereof to online content and software in one's home language
Geographic location	Individuals living in rural areas are more likely to have less physical access to hardware and connectivity than urban areas
Cultural	Certain cultural beliefs may restrict certain individual's access to ICTs
Gender	Certain gender beliefs and stereo-typing may restrict certain individuals' access to ICTs
Race	Linked closely to culture
Illiteracy	An individual's literacy level may restrict their effective use of ICTs
Computer attitude	An individual's acceptance of and attitude towards ICTs may affect their effective use of ICTs

2.3.1. Physical factor

One of the numerous barriers to the effective use of ICTs identified in the literature is a physical barrier, which quite simply defined, is a lack of access to the actual computer hardware and the Internet (Brown & Czerniewicz, 2007; Czerniewicz & Brown, 2006; Gudmundsdottir, 2005). An individual is obviously unable to learn to use ICTs and relevant applications if he or she does not have access to one. The e-Divide Team (2006), state that individuals who do not have access to physical resources are generally those who come from

lower socio-economic brackets. They go on to add that the determining factors of who has access and what the quality of that access is, are race, gender, linguistic capability, cultural heritage and income.

2.3.2. Digital factor

Tied closely to physical barriers are digital barriers. Such barriers include a lack of access to relevant and useful software and a lack of access to online content in an understandable format, language and cultural relevance. Inability to utilise the Internet in order to connect with other individuals from different regions, cultures and socioeconomic statuses is also identified as a digital barrier (Gudmundsdottir, 2005). As the focus in current debates moves from material or physical access to the skills and opportunities that an individual has to possess in order to be able to use ICTs, it is apparent that just having access does not guarantee the ability to use or make use of ICTs. Gudmundsdottir (2005) elaborates by analogising that by having access to books does not mean that you will be able to read them, let alone use their content to your own benefit.

2.3.3. Human factor

Human barriers highlight the lack of human resources, such as experienced and trained facilitators who would be able to help the individuals develop an adequate knowledge and necessary skills in using ICTs. Schools in a low socio-economic bracket are often unable to attract well-qualified, digitally competent teachers. Engaging with a trained and experienced facilitator helps to develop previous experience. Brown & Czerniewicz (2010) found in their on-going six year study of South African university students that this was a greater determining factor in successful ICT use, than age. Researchers suggest that educators play an important role as models when technology is involved (Markauskaite, 2005).

2.3.4. Socio-economic factor

An underlying mechanism is one of socio-economics. Students in a low socio-economic group may experience a lack of resources which can include maintenance, use, effectiveness etc. In my research, students indicate that the resources may be present, even in schools that fall into a low socio-economic bracket. The problem is that these computers are locked away in the computer lab and teachers and students are not allowed to utilise them for fear that they might “break” them. This may be evidence of the school’s lack of acknowledgement of technology’s growing importance, as well as a lack of acceptance of technology in lower

socio-economic groups. The digital divide is the gap between individuals, households, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access ICTs and their use of the Internet for a wide range of activities (Organisation for Economic Co-operation and Development (OECD), 2001).

In 2011, PEW Research Centre's Internet director Lee Rainie presented an overview of recent United States data that focuses on key behavioural statistics of the Millenial generation. He reported that individuals with higher incomes are more inclined to use technology and the Internet more often than those in middle and lower income categories. He also found that the demographics of so-called digital natives indicated that most are white (61%) and live in the suburbs (54%) (Rainie, 2011). Students participate in most research, yet these individuals do not specifically represent whole populations because they tend to form a segment of the population that has the financial capacity to afford to go to college (Bennett & Maton, 2010). There are numerous studies investigating the existence and extent of a digital divide in South Africa such as those conducted by (Castells, 1999; Compaine, 2001; Gudmundsdottir, 2005; Martindale, 2002). Brown and Czerniewicz (2010) frame it well: it is not about a generation, rather it is about an elite. In their research in South African universities, they found that ICT use was along socio-economic lines. Twenty-two percent of the students surveyed lacked both experience and opportunity to use ICT, had less than four years of experience and had no ICT access off-campus (Brown & Czerniewicz, 2010).

2.3.5. Age factor

As previously discussed, Prensky proposed an age divide between digital natives and digital immigrants. Digital natives are also referred to as Millennials by Strauss and Howe, and are individuals who have never known a world without pervasive computer and communication technologies. While these students may have been born in a millennial generation, it cannot be assumed that they have grown up to be digitally competent. Sayago, Santos, Gonzalez, Arenas, & Lopez (2007), conducted research into whether older individuals learn differently and although they focused predominantly on the elderly, they highlight the importance of peer support as the scaffolding mechanism for the older students' entry into the technological learning environment (Junco & Mastrodicasa, 2007). Clarke (1998) proposes learning about information technology as being well within the capabilities of most adults regardless of their age, gender or previous educational experience (Clarke, 1998). Brown and Czerniewicz (2010) argue that age is not a factor. Familiarity and experience using ICTs plays a greater

role. American research shows that digital natives do not necessarily contribute to social sites. Only 36% contribute to blogs, 40% to wikis, and only 42% contribute the video sites. Social games and social bookmarking sites are only used by 25% of so called digital natives. Fewer than 20% of the students said that they used course lecture podcasts or videos (Smith & Caruso, 2010). Research conducted by Kennedy, Judd, Dalgarna and Waycott in Australia revealed similar results. They found that 45% of digital natives were basic technology users (Kennedy, Judd, Dalgarno, & Waycott, 2010).

2.3.6. Language factor

Language is another factor that arises in the literature. Inequality of access is a reality for South African students from low socio-economic groupings, and those who do not speak English as a home language have been found to have very low access to ICTs off campus (Czerniewicz & Brown, 2009). Other studies into the issue of language acting as a barrier to the effective use of ICTs in South Africa have been conducted (Barnard, Cloete, & Patel, 2003; Czerniewicz & Brown, 2006; Gudmundsdottir, 2008; Institute for Dynamic Educational Advancement, 2007; Keniston, 2001; Martindale, 2002; Seymour & Fourie, 2010).

Gudmundsdottir (2008) states that it should be the right of every learner to have the opportunity to learn and be taught in his or her mother tongue as this would take South Africa closer to educational equality as is identified in the constitution (Gudmundsdottir, 2008). Students that enrolled for the pre-service teaching degree at the HEI in 2013 and 2014 were from a diverse population group. With 11 official languages in South Africa, it was likely that many of these students did not speak English as their home language.

Martindale (2002), in an article for a Linux journal promoting a non-profit open source translation project in South Africa, makes powerful comments regarding the divide language imposes on the use of technology. Martindale argues that navigating the digital world is daunting for first time users without having to do it in a language that is not their home language. This translation project, translate.org.za, founded by Dwayne Bailey, focuses on the localisation of open source, free to download, software and has released the popular word-processing, spreadsheet and presentation software OpenOffice.org, web browser Mozilla Firefox and e-mail programme Mozilla Thunderbird in the 11 official South African languages. The first all-South African language keyboard is rated as the world's first. Venda (one of the official languages) cannot be accurately typed on traditional keyboard but this has

now changed with the development of this new keyboard. Translate has also made 'spell checkers' for all 11 languages (Kabissa, unknown).

During the apartheid period, language policy was used for political purposes to further separate different learner groups. English has predominantly become the language of learning and teaching and this is also true at the HEI. The lack of linguistically appropriate educational software is an important issue as Keniston (2001), points out in his study that in order to minimise the power structures between the rich and poor, software that ensures the content of the Internet is meaningful for different language groups needs to be developed. This was addressed by Thabo Mbeki's Presidential National Commission on Information Society and Development when he advised that care should be taken not to perpetuate the domination of nations of the world by certain languages and cultures. To ensure that all communities feel part of the global information society, the content on ICTs needs to be relevant and appropriate to all communities as well as available in their languages (PNC on ISAD, 2009).

Before this translation initiative, software programmes were written for English speakers. A novice ICT user is already disadvantaged when he or she faces using ICTs and receiving instruction on the use of ICTs in a language that is not his or her home language. Czerniewicz and Brown (2006) argue that it would be greatly beneficial for the students if more emphasis was placed on the language issue in the South African context. They go on to state that they are "astounded that the paucity of relevant local digital content is not considered a matter of concern, and that students do not bemoan their lack of access to suitable, locally produced contextually relevant content in the languages of their choice" (Czerniewicz & Brown, 2006: 136). There are very few documents available on the Internet in African languages, written by Africans themselves. As long as there is limited localisation of content which does not take into account all the different languages, the status of English will continue to have the upper hand and will continue to be a hindrance for the learning process and ICT competence of all students (Gudmundsdottir, 2008).

Learning something in your mother tongue is naturally easier and whilst the issues that surround language, inequality and poverty are broad and impact every sphere of life. Bailey (in Martindale, 2002) acknowledges that translation does not remove all barriers to ICT access, but points out that at least it helps to eliminate one. Bailey feels that this, together,

with low cost computers, open source software and low cost Internet access will go a long way to making a dramatic IT impact on South Africans, especially the disadvantaged.

2.3.7. Cultural factor

In addition to the multi-lingual nature of the country, South Africa is made of people of differing cultures. Evidence of this is the existence of numerous cultural groups which include the Zulu, Xhosa, Ndebele, Sotho, Venda, Pedi, Tsonga, Tswana, Swati. Some individuals may be barred from using ICTs due to cultural beliefs which are often linked to gender issues. Bourdieu investigated the impact that an individual's history or disposition, seen to be a result of one's culture and social-standing, had on their current experience and behaviour. An individual's *habitus* or world-view is one's way of perceiving, emotionally responding to and evaluating the world. This *habitus* is the product of an individual's family experience over generations (Fowler, 1999). While the actual habitus may not be visible, one is likely to see the effects of the habitus and the practices and beliefs that it gives rise to (Maton, 2008). Students from different social structures form part of my research population and the advantage that certain groups may have due to their cultural capital is relevant. Simply defined, cultural capital is the inborn talent or disposition an individual comes to a learning practice with. This cultural capital is acquired in the home and school via exposure to a given set of cultural practices. Everyone comes to the environment with a set of predetermined abilities (Weininger & Lareau, 2007).

2.3.8. Race factor

Race and culture are very closely linked in South Africa as its population is comprised of many different races. These include Africans, Whites, Indians and Coloureds. While there is little to no literature detailing the impact that race may have on one's ICT usage, it is valuable to establish whether it is indeed a factor in the students' effective use of ICTs. The inequities reflected in South Africa's education system relate to a long history of racialised education provision. Opportunities for black students, particularly black students from poor backgrounds were severely limited. Until the early 1990s, black students entered higher education institutions in very low numbers. They also only attended particular institutions (Badat, 2009; Bunting, 2002). After 1990 there was a significant increase in the higher education enrolment figures of black students. Black student numbers grew from 55 percent in 1994 to 81 percent in 2011 (Department of Higher Education and Training, 2012, 2013). However, trends of participation still reflect past patterns of inequality. Of the total number

of students aged 20 to 24 years of age, black and coloured students participate in higher education at a rate of 14 percent and 15 percent respectively. Indians at a rate of 46 percent and white students 57 percent (Council on Higher Education, 2013). Given the wide racial disparities in participation, access remains a significant focus of policy and political discussion (Lewin & Mawoyo, 2014).

2.3.9. Gender factor

Gender factors may be linked to cultural beliefs and these may result in women's access to ICTs being more problematic and complex than simply making computers available (Colle & Roman, 2002). These barriers include literacy, education, language, cost, locality, the perceived role of women as well as technophobia - the fear or dislike of ICTs. These are barriers that exist widely and more severely for women, particularly in Africa. Liu & Wilson (2001) identify five barriers that may restrict women in their use of ICTs. These include family responsibility, gender stereotypes and attitudes, working time constraints as well as a lack of confidence and a lack of digital competence skills.

In Markauskaite's 2005 study exploring the differences in 217 Australian postgraduate trainee teachers' ICT literacy levels and the role gender played on this. She found no significant difference between females and males previous experience with ICTs. However, males on average work with computers significantly more hours per week than females. Significant differences between males and females technical ICT capabilities were observed with male students scoring higher. When analysing the impact of background and ICT experience, she found that gender fails to be a significant predictor of sustainability of ICT use. However, gender remains a significant predictor of some trainee teachers' technical capability scores when compared with males' scores (Markauskaite, 2005).

Since the invention of the computer, ICT-related activities have been viewed as a "male domain". In schools, a computer was primarily associated with programming and logical scientific thinking. Thus, old stereotypic gender differences in attitudes and achievements that previously existed in Mathematics and technological disciplines were extrapolated to the area of ICT. As several research reviews and meta-analyses summarised, boys were more interested in ICT than girls, they were heavier users of computers, had more positive attitudes about computers and consequently outperformed girls in their ICT literacy (Reinen & Plomp, 1996; Volman & Eck, 2001). This research was conducted over 20 years ago. During the last two decades, the role of ICT in education changed radically. New technologies have

become an indispensable aspect of learning, work and everyday life. A number of recent studies evidenced that ICT-related differences between males and females lessened mainly in the access to ICT and basic computer skills (Busch, 1995; Rainer, Laosethakul, & Astone, 2003). While gender differences in ICT-related attitudes and cognitions disappeared at scale level, they seem to persist at factor level (Mc Ilroy, Bunting, Tierney, & Gordon, 2001). In addition, female and male students are likely to be different in terms of the types of computer use rather than in all areas of ICT application (Colley, 2003; Mitra et al., 2001).

2.3.10. Geographic location factor

Prensky stated that he expected children all over the world to exhibit digital native behaviour (Prensky, 2003). However, research has shown that location does matter. Studies into the levels of computer and web technology usage among the same demographic of digital natives show clear differences. Brown and Czerniewicz (2010) show that only 26% of the South African population might be described as having grown up digital (Czerniewicz & Brown, 2010). Not only are South Africans diverse in the languages they speak, they are also geographically wide spread. People living in rural areas are less likely to have access to ICTs and the Internet when compared to urban areas. The language that is spoken in a rural area may also impact on the individual's access to ICTs. These areas are more likely to be economically depressed and there is often a lack of infrastructure in rural areas (Institute for Dynamic Educational Advancement, 2007; NetTel, 2004). While fair access may be available on the HEI campus, one needs to bear in mind that the students come from and live in unequal worlds off campus where access to ICTs may be unequal and perpetuated by disadvantage (Brown & Czerniewicz, 2007). This relates to some of the factors that have been previously mentioned.

Formulas for introducing hardware, infrastructure, training and applications become problematic in the face of dramatic differences in environment and culture in areas too remote to have them already. Poverty there can keep commercial interests from seeing such areas as "markets", an important motivation for obtaining corporate support while some governments just see technology as a luxury for affluent citizens not as a tool for national development (IDEA, 2007).

2.3.11. Illiteracy factor

South Africa has a large percentage of uneducated citizens. NetTel (2004) predicts that illiteracy statistics will be drastically reduced if technical or computer skills are imparted to

most members of society. Figures regarding the actual number of illiterate individuals are hard to find. As Gustafsson, Van Der Berg, Shepherd and Burger (2009) explain, self-reported ability to read and behavioural variables such as reading habits, produce vastly different measures of adult literacy in South Africa. There is no direct measure and they suggest a 75% literacy rate as a plausible figure (Gustafsson, et al., 2009). *Statistics South Africa* reported that that 93.73% of people aged 15 and over were classified as literate in 2013. Adult literacy in this case is defined as being able to read and write with understanding a short simple statement about their everyday life (Index Mundi, 2016). In 2015 UNESCO defined the literacy rate of 15 year old individuals and over at 93.13%. These statistics are sourced from national population censuses, household surveys and labour force surveys. As mentioned previously, these are again self-reported ability accounts. The way that literacy has been defined and measured is problematic. Long, the literacy programme co-ordinator for the non-government organization (NGO) GADRA Education, explains that literate individuals are also able to interpret text and read for meaning and not just decipher the symbols which make up words (Pretorius, 2013).

NetTel (2004) continues to suggest that people should not just gain access to computers, but should also have the opportunity to learn various computer applications to ensure that they can be employable. This will reduce the high unemployment rate in South Africa which is currently estimated at 25% (Trading Economics, 2016). I include this factor in my research, firstly, because it was raised in the literature as a possible barrier to the development of digital competence and secondly, because South Africa finished close to last, 139 out of 143 countries when looking at the overall quality of its education system (World Economic Forum, 2015).

2.3.12. Learning barriers

As mentioned previously, Darkenwald and Merriam (1982) identified four general categories of learning barriers in adult learning. Not many other studies have been conducted to examine learning barriers in the context of ICTs. In Purnomo and Lee's 2010 study looking into readiness and barriers towards an ICT Programme for agricultural extension officers in Indonesia, four categories of barriers were identified. The first barrier is an organisational culture barrier which results in a lack of training availability to learn how to use ICTs. Secondly individual barriers include an individual's lack of confidence in their own ability to use ICTs, a lack of motivation towards using ICTs, language problems towards using ICTs

and a lack of skills to use ICTs. Thirdly, technological barriers were identified that included finance and finally policy barriers (Purnomo & Lee, 2010). A similar study into the barriers to ICT integration in Turkey identified three categories. These categories are resources, knowledge and skills and lastly attitudes and beliefs (Kula, 2010).

Students in my research were asked to identify any factor that they felt impacted negatively on their effective use of ICTs. I present my findings with regards these factors in chapter six and go on further in chapter seven to focus on confidence, attitude and a belief in one's own ability, which were also identified as barriers in the above mentioned studies.

2.4. Research in computer attitude and digital self-efficacy

"Sometimes when I want to perform a task, I usually don't know where to start and sometimes I am scared that I might damage my phone or the computer if I do what I don't know" (18 year old female).

There are studies that investigate pre-service teachers' computer attitude (Liu et al., 2004; Shapka & Ferrari, 2003; Teo, Lee, & Chai, 2008; Wong, Ng, Nawawi, & Tang, 2005; Yildirim, 2000) while others deal with the development of computer self-efficacy (Fisher, 2000). Askar & Umay (2001) look at both self-efficacy and attitudes, but their focus is on pre-service elementary mathematics teachers in Turkey.

2.4.1. Computer attitude

Attitude is a way of thinking and behaving. Computer attitude is an individual's attitude towards using a computer. A positive attitude is likely to enhance the learning process, while a negative attitude may lead to computer resistance. An individual's attitude towards computers and related technology could determine his or her performance with the technology (Jawahar & Elango, 2001; Seymour & Fourie, 2010; Shneiderman, 1980). Computer literacy promoters have fed computer apprehension with warnings that "ignorance of computers will render people as functionally illiterate as ignorance of reading, writing and arithmetic" (Donald Michael quoted in (Fiske, 1983) page 28). By making individuals aware of what they do not yet know about ICTs, they are driven to become more familiar with them.

As discussed previously in section 2.3., the fourth category in Darkenwald and Merriam's learning barriers in adult learning is *psychological barriers*. These are individually held beliefs, values, attitudes or perceptions that inhibit participation in learning activities. These

psychological barriers are relevant in light of the investigation into possible barriers that students face when accessing ICTs. Teo, Lee, & Chai (2008) state that computer attitude may act as either a facilitator or barrier to computer use, with consequences for a student's learning. This computer attitude is influenced by different variables which include perceived usefulness of the technology, computer confidence, training, gender as well as knowledge about computers. In addition to these, computer anxiety and liking, as well as computer experience impact on an individual's computer attitude. Teo, et al. (2008) point out that these factors interact with each other to impact on the individual's attitude towards computers. Research has shown that a positive attitude has the ability to predict future computer usage (Myers & Halpin, 2002; Schunk & Pajares, 2002; Shapka & Ferrari, 2003; Yildirim, 2000). Even in 1994 it was determined that a positive, anxiety-free attitude towards computing was a necessary prerequisite of computer literacy for all teachers (Hess, 1994). Technophobia can be seen to be a barrier that people may experience as they fear the computer, and are resistant to using ICTS because it is assumed that it is too difficult to use or because an individual's first experience with such devices may have been unpleasant. NetTel (2004) states that one of the reasons an individual may not use ICTs is due to ignorance or lack of awareness of how ICTs may assist them.

The relevance for investigating the students' computer attitudes in my study is supported by Khine's (2001) study of 184 pre-service teachers in which their use of ICTs was examined through a study of their attitudes towards computers. It was found that a significant relationship between their computer attitude and ICT use in the institution existed. Findings with regards the computer attitude of students in my study will better inform course designers whether attitude is either a barrier or enabler that students face when accessing ICTs.

2.4.2. Digital self-efficacy

Digital competence, earlier defined as possessing the essential knowledge and skills needed to function independently with digital devices, is not the same thing as digital self-efficacy. Digital self-efficacy (DSE) is not a skill, ability or competence, but rather, it is a belief in one's own ability to use ICTs. While one's own skill in the use of ICTs may shape one's own DSE, it is possible that one's DSE may shape the actual skill of using ICTs. Bandura's Social Cognitive Theory is a widely accepted, empirically validated model of individual behaviour (Compeau & Higgins, 1995). In this model, behaviour is determined by environmental influences, such as social pressures, situational characteristics, cognitive and

other personal factors. These personal factors may include personality as well as demographic characteristics.

Social Cognitive Theory has many dimensions, and through a focus on the cognitive factors in an individual's behaviour, Bandura advances two sets of expectations as the major cognitive forces guiding behaviour. The first set of expectations relate to outcomes. It is believed that individuals are more likely to undertake behaviours they believe will result in valued outcomes than those they do not see as having favourable consequences. The second set is relevant to my study. This set encompasses what Bandura calls self-efficacy or beliefs about one's ability to perform a particular behaviour. Self-efficacy influences an individual's choices about which behaviours to undertake. This self-efficacy includes the effort as well as the persistence exerted in the face of obstacles to performing these behaviours. It ultimately results in the mastery of the behaviours (Compeau & Higgins, 1995). From the above it is evident that an individual's digital self-efficacy may be influenced by the barriers that they encounter when accessing ICTs. This reinforces the notion that the phenomena that an individual encounters when using ICTs impact on the final experience of developing digital competence.

Numerous factors that may impact on an individual's ICT usage have been identified in both local and international studies. There are also studies both locally and internationally that investigate computer attitude as well as the development of digital self-efficacy in pre-service teachers. I did not encounter any studies that looked at both South African pre-service teachers' conceptions of digital competence and the impact that certain factors, specifically attitude and self-efficacy may have on their development of digital competence. My study focused on this area in addition to documenting the students' actual accounts of coming to be digitally competent.

2.5. Models of skill acquisition

Models of skill acquisition are useful in explaining how individuals come to master a skill. The Dreyfus and Dreyfus skill development theory makes the distinction between "knowing that" and "knowing how." Dreyfus and Dreyfus state that human beings acquire a skill through instruction and experiences and that they do not appear to leap suddenly from rule-guided "knowing that" to experience-based "knowing how" (Dreyfus & Dreyfus, 1986).

In table 4 below and the subsequent explanation below it, the model proposes that an individual passes through five distinct stages: novice, beginner, competent, proficient and expert.

Table 4: Five stages of skill acquisition (Dreyfus, 2004)

Skill level	Components	Perspective	Decision	Commitment
1. Novice	Context free	None	Analytic	Detached
2. Advanced Beginner	Context free and situational	None	Analytic	Detached
3. Competent	Context free and situational	Chosen	Analytic	Detached understanding and deciding: involved outcome
4. Proficient	Context free and situational	Experienced	Analytic	Involved understanding: detached deciding
5. Expert	Context free and situational	Experienced	Intuitive	Involved

In table 4 above, **components** refer to the elements of the situation that the individual is able to perceive. These can be context free and pertaining to general aspects of the skill or they can be situational, which means they only relate to the specific situation that the individual is in. **Perspective** develops as the individual begins to be able to recognise almost innumerable components and he or she must choose which one to focus on. A **decision** is made by the individual as how to act in the situation he or she is in. This can be based on analytic reasoning or an intuitive decision based on experience and holistic discrimination of the particular situation. **Commitment** describes the degree to which the individual is immersed in the learning situation when it comes to understanding, deciding, and the outcome of the situation–action pairing (Dreyfus, 2004).

The Dreyfus and Dreyfus (1986) model, used by the Dreyfus brothers to study the practice of chess players and nurses, has conventionally been used to explain adult skill acquisition. While a reliance on models may limit a researcher, they can be useful in helping simplify and foster understanding of what is not really condensable (Batalden, Leach, Swing, Dreyfus, & Dreyfus, 2001). The learners in my research ranged from 17 to 40 years of age. The average age of the students was 19.6 years old. In South Africa, individuals are legally defined as

adults when they reach 18. It is generally accepted in research that adult learners are individuals over the age of 25. The University of Illinois states that an adult learner is a lifelong learner generally 25 years old or older and this individual has additional responsibilities such as family, career, military, or community, and is seeking a degree or other educational offering to enhance their professional and, or personal lives (University College, 2016). However, as Hansman and Mott point out in their chapter on adult learners, the definition of an adult is culturally and socially derived. Researchers in other countries and cultures may capture ideas about adults differently than Western cultures, often including other factors besides chronological age in their understandings of adulthood, such as gender, ethnicity, religion and behaviours (Hansman & Mott, 2010). They elaborate on this, stating that psychological maturity levels and social roles, as well as life situations, also define adulthood. For instance, individuals younger than 18 who are parents or caregivers of others, or traditional age university students working full time to support themselves and pay tuition, may be considered adults.

Bjorklund and Bee suggest that age is just a number as adulthood has several dimensions that affect learning. While chronological age represents the literal number of years one has lived, biological age (physical condition), psychological (developmental maturity), and social age (perception of roles and expectations at any given point in life) are different measures of age that may significantly impact an adult's desire for and ability to pursue learning (Bjorklund & Bee, 2008). Adult learners are those adults who engage in learning activities that may promote any sustained change in thinking, values, or behaviour (Cranton, 1992). There is no typical adult student. Models of adult skill acquisition are appropriate to apply to the young adults in my research. They are engaged in higher education study having chosen a life-long learning activity for their future career– their teaching degree. Studies applying the Dreyfus and Dreyfus model of skill acquisition with young adults include a recent one in Nigeria that investigated the process of skill acquisition in soap making of 84 youths (Omeje, Kuchi, & Ogwa, 2016) and the effects of an equine short course on Texas youths aged 14 to 18 years old (Capeheart, 2015).

Other models of mastery exist in addition to the Dreyfus model. Sprague & Stuart (2000) present a four stage developmental trajectory from novice to expert focused on two dimensions: competence and consciousness. Individuals move from a state of unconscious incompetence to conscious incompetence to conscious competence until they reach the

desired state of unconscious competence. I used the Dreyfus and Dreyfus model as it was extended to include adult skill acquisition by one of the authors, Stuart Dreyfus in 2004. As I believe digital competence to be the development of skills, it follows that it is possible to use a model of skill acquisition to examine how the students achieve a desired level of digital autonomy or digital competence. The Dreyfus model, a *just-in-case* approach, is supported by Ambrose, Bridges, DiPietro, Lovett, & Norman (2010) who state that in order to develop mastery, individuals must acquire component skills, practise integrating them and know when to apply what they have learned. A just-in-time approach differs from this as it proposes that fundamental knowledge is best acquired in the process of useful activity, and not acquired beforehand in useless introductions (Nobel, 1984: 603). This just-in-time approach was further explored earlier in section 2.1.2.

In chapter six, I investigate the correlation of Dreyfus and Dreyfus' five stages of skill acquisition with the ICT development levels proposed by the South African White Paper on eEducation, 2004. The White Paper outlines the ICT development levels that are included in teacher development frameworks. The ICT development levels identified are: an entry level, adoption level, adaptation level, appropriation level and innovation level (Department of Education, 2004). I initially thought that it was not possible to explain the process of coming to be digitally competent without considering a model of skill acquisition. Using a skills acquisition model proved useful in explaining the levels or stages that a student may pass through in their endeavour to master a skill. However, as I show in chapter eight, the development of digital competence is not simply explained as the simple progression through pre-determined linear stages.

2.6. Concluding remarks

A certain degree of digital competence is necessary for first year students to succeed at a higher education institution. Whether this learning happens on a just-in-time or just-in-case basis, the South African White Paper on eEducation stipulates that teachers need to have a certain degree of digital competence when they graduate. Graduating teachers need to be able to use various ICTs, including computers, to support traditional management, administration, teaching and learning, and be able to teach learners how to use ICTs. Acknowledging and attempting to minimise the barriers that students may encounter when accessing ICTs is important. In chapter two I examined literature that provided a theoretical background and insight into the research questions I focus on in my research.

I found certain gaps that warranted further investigation. Firstly I did not find any studies that detailed the process of how pre-service teaching students came to be digitally competent and secondly, the possible impact that computer attitude and digital self-efficacy may play on this development. Research question one addresses the first year pre-service teaching students' perceptions of digital competence. This research question is answered in chapter five. In the literature review I traced the history of the terms computer literacy, information literacy and digital literacy before proposing the encompassing term; digital competence. I drew up table 2 which is used again in chapter five to analyse the students' responses to their understanding of what it means to be digitally competent. This table summarises the key components of digital competence identified by various researchers. Teaching and assessing digital competence is explored and the debate between the two approaches of teaching just-in-time skills versus just-in-case skills introduced. Discussion of literature and research in the area of assessment of digital competence provides a background to the various assessment approaches. This is useful in addressing research question two which identifies the first year pre-service teaching students' current levels of digital competence.

Research question three explores the factors and divides that possibly inhibit or afford the development of the first year pre-service teachers' digital competence. Focus is placed on the factors of computer attitude and digital competence. While numerous factors are identified in the literature, only certain of these are common to the student population participating in my research.

The final research question explores how the first year pre-service teaching students develop a degree of digital competence in their first year at the HEI. While research into the teaching and assessment of digital competence is touched on in chapter two, the analytical reasoning that drives this question is presented in chapter four. Research question four is answered in chapter eight. The following methodology chapter details the procedures I followed when conducting my research.

Chapter 3 - Methodology

In this chapter I describe the research methodology that I used as I set out to answer my research questions. I start by describing my ontological and epistemological position and how this influences the methodologies used. Within my descriptions of each methodology, I explain why, how and when these methodologies were used. I detail the design, piloting and use of research instruments for each methodology, and justify the sampling procedures used. A discussion of how I address the issue of ethics and rigour in my research concludes the chapter.

3.1. Personal philosophy and research paradigms

In this section I establish my philosophical assumptions and the methodology I employed and the research instruments I used in my research. Social scientists have looked at the philosophical foundations of different types of research and have attempted to identify and classify the theoretical underpinnings, paradigms or worldviews within which researchers work and from which their methodology emerges (Bogdan & Biklen, 2007). Whether we are aware of it or not, we all operate on a belief system. As researchers, it is vital that we know where we stand before we embark on our research. Through understanding my own belief systems I can then see the underlying beliefs and prejudices in others' work, as well as my own. A paradigm is simply a belief system, or theory, that guides the way we do things. Research is a systematic investigation or inquiry whereby data is collected, analysed and interpreted in some way to understand, describe, predict or control an educational or psychological phenomenon (Burns, 1997). This is done in order to empower individuals in such contexts (Mertens, 2005). According to Guba, paradigms can be characterised through their: ontology – what is reality?, epistemology – how do you know something?, and methodology – how do we go about finding out ? (Guba, 1991).

Ontology is what exists and is a researcher's view on the nature of reality. I present three ontologies: Realism, Critical Realism and Relativism. When thinking about the nature of reality, a **Realist** acknowledges that there is something out there, which as a law of nature is just waiting to be found. It exists independently from our conceptions of it. A reaction to this is **Critical Realism**, a social theory in which the researcher knows things exist out there but as human beings our own presence as researchers influences what we are trying to measure. However, the researcher cannot observe anything in the world without a prior

theory about what it might mean. Following on from this, in **Relativism**, researchers believe that knowledge is a social reality, value-laden and it only comes to light through individual interpretation. Truth is always relative to a particular frame of reference (Scott & Morrison, 2007). My ontological position is one of a critical realist. I acknowledge that things exist but I am aware that my presence as a researcher influences what I am trying to measure. It is an approach that assumes that multiple causal agents operate as generative mechanisms at various levels: social, socio-economic, cultural, and or digital, for example. Relations between these agents exist and a critical realist attempts to explain how phenomena are related to and explained by the structures underlying them (Norrie, 2005). Such a view is congruent with the analytical approach that I employed in my thesis. Actor network theory views society consisting of networks of any material entity, human or nonhuman. The agency, or capacity to act, of actors constitutes the network, rather than mere connections of human and non-human actors (Ellis, 2013). I elaborate on my application of actor network theory in chapter four.

Epistemology is our perceived relationship with the knowledge we are discovering. Are we part of that knowledge or are we external to it? A researcher's view on knowledge frames their interaction with what they are researching. The researcher's theoretical approach will be objective if they view knowledge as governed by the laws of nature. Alternatively, their approach is subjective if they view knowledge as something interpreted by individuals. This in turn affects a researcher's methodology (Guba, 1991). This theoretical framework influences the way knowledge is studied and interpreted. It is the choice of framework that sets down the intent, motivation and expectations for the research (Bogdan & Biklen, 2007; Mertens, 2005). Without nominating a framework as the first step, there is no basis for subsequent choices regarding methodology, methods, literature or research design (Mackenzie & Knipe, 2006). These are lenses or frameworks that are employed when conducting educational research. I present three such frameworks; positivism, constructivism and interpretivism in this chapter.

Positivism assumes that reality exists out there and that it is observable, stable and measurable. It is an approach that may be applied to the social world on the assumption that the social world can be studied in the same ways as the natural world, that there is a method for studying the social world that is value free (Mertens, 2005). Positivists aim to test a theory or describe an experience through observation and measurement in order to predict

and control forces that surround us (O'Leary, 2004). A positivist position assumes that reality exists out there and is just waiting to be found. This links closely to the previously mentioned realist ontological view. Postpositivists recognise that knowledge is relative, but that the researcher collects data that best describes the reality. Postpositivists see the world as ambiguous, variable and multiple in its realities. What might be the truth for one person or cultural group, may not be the truth for another (O'Leary, 2004). **Interpretivist** research, which is the theoretical perspective I took, assumes that reality is socially constructed and that there are multiple realities or multiple interpretations of a single event. Interpretivist researchers have the intention of understanding the world of human experience (Cohen & Manion, 1994). I elaborate more on this theoretical perspective in the following chapter four, where I expand on my analytical reasoning.

A **constructivist** paradigm, similar, and often combined with an interpretivist one, relies upon the participants' views of the situation being studied (Cresswell, 2003) and recognises the impact on the research that their own backgrounds and experiences play. My epistemological position is that people construct their own understanding of truth or knowledge, and that this is personal, subjective and unique. While my research was initially located in the **postpositivist** paradigm, as I collected quantitative data that underpinned my research, I acknowledge that it then moved into the interpretivist paradigm. This is when, through qualitative methods, such as interviews, I probed further to better understand the students' realities more deeply. My particular interest was in the influence of external and internal factors on the students' development of a required degree of digital competence.

I have introduced the theoretical paradigms within which I locate my research. I now explain how I go about answering my research questions and the methods I used to carry out my research. This is referred to as methodology. This is the way researchers collect and analyse data (McMillan & Schumacher, 2006). Methodology is the theory, or set of ideas about the relationship between phenomena. It is how researchers gain knowledge in research contexts and why. It is a strategic approach, rather than just techniques and data analysis (Wainwright, 1997). Some examples of such methods are:

- The scientific method, a quantitative method
- The ethnographic approach, a qualitative method
- The case study approach, a qualitative method
- The ideological framework, or set of beliefs guiding the research

- The dialectic approach which compares and contrasts different points of view or constructs, including your own.

I employed a mixed-methods approach which combines quantitative and qualitative methods in one research project.

3.2. Research Design – a mixed methods approach

Research is the systematic process of collecting and logically analysing data for some purpose (McMillan & Schumacher, 2006). The way in which data is collected and analysed is referred to as the method and denotes the tools or techniques used to collect, analyse and interpret data in education research. These methods are used to confirm the knowledge that the researcher has created has reliability and validity (Scott & Morrison, 2007).

One of the aims of my research was to investigate any correlation between a student's attitude and self-efficacy in the development of their digital competence. The research design best suited to my research was a mixed method approach of both qualitative (case study) and quantitative (survey) methods, employing an interpretative paradigm and explanatory framework. Such a method is concerned with describing the nature or conditions in detail of the situation under study. The emphasis is on description, rather than judgement (McMillan & Schumacher, 2006). A mixed-methods approach describes achievement, attitudes, behaviours or other characteristics of a group of students.

A mixed method approach allowed me to select quantitative and qualitative research methods on the basis of their ability to generate data that provided answers to my research questions (Johnson & Onwuegbuzie, 2004). I could quantitatively present findings with regards to the students' baseline digital competence test results and their computer attitude and digital self-efficacy scores. On a deeper level, through qualitative means, I was better able to understand *why* the students had not achieved the desired level of digital competence. I studied these issues through interviewing the students. By combining quantitative data with qualitative date, a more complete understanding of the relationship between computer attitude, digital self-efficacy levels and the development of digital competence was developed.

My research questions examine whether digital self-efficacy, computer attitude as well as unique situational factors impact on a student's development of digital competence. In an attempt to understand the phenomena better, I used a framework that aimed to capture the lives of the participants in order to understand and interpret the meaning. My approach had

methodological implications as the emphasis was on experience and interpretation. I focused on understanding the first year pre-service teaching students' experiences and perceptions in their coming to be digitally competent, from the standpoint of their own unique contexts and backgrounds (Henning, et al., 2004).

Figure 4 below helps to better clarify the design of my research. A mixed methods approach is clearly evident in the use of both quantitative and qualitative data collection methods.

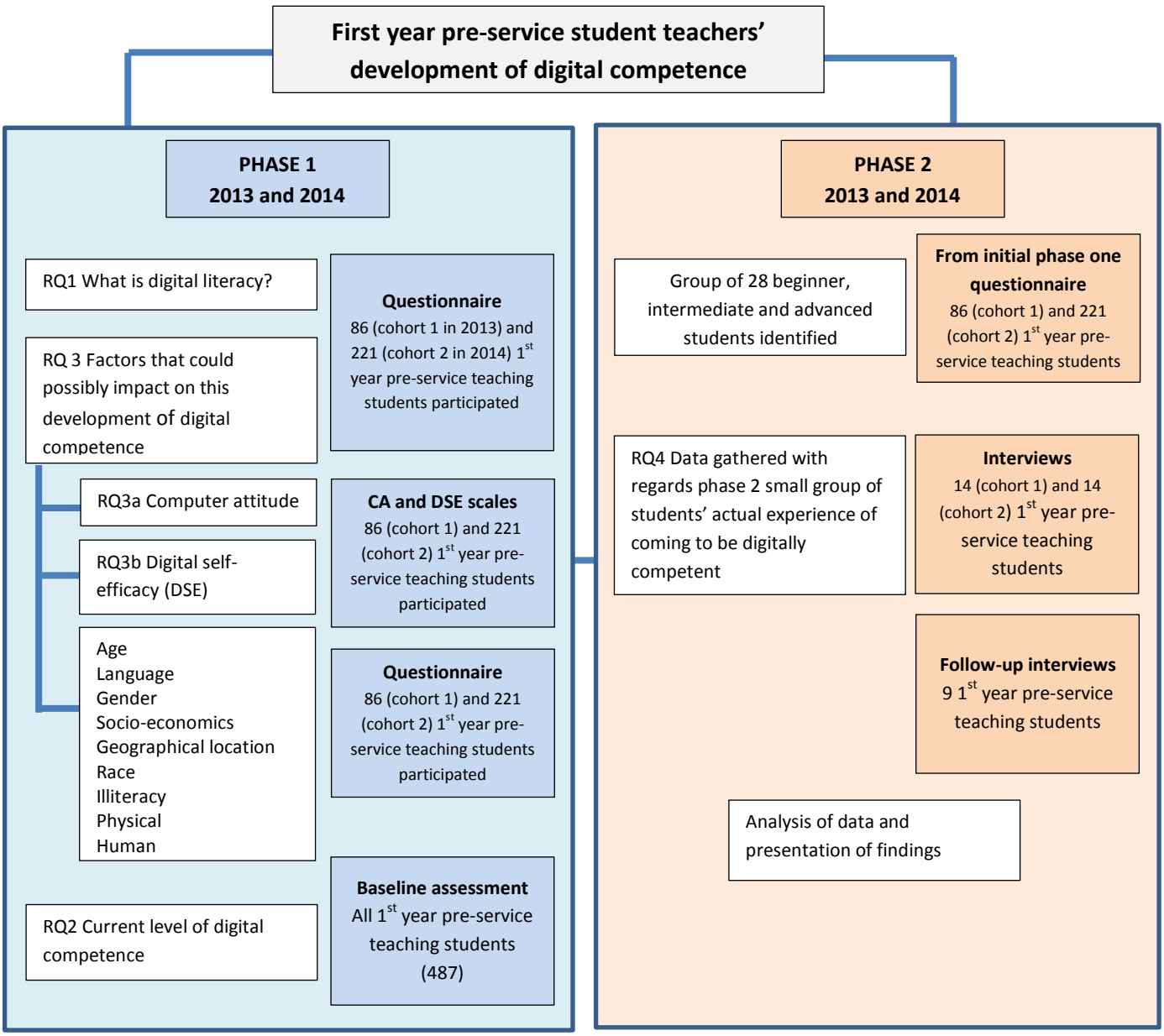


Figure 4: Final research design

Research questions one, two and three were addressed in phase one of my research design. Both quantitative data and qualitative data was collected in phase one. Research question four was addressed in phase two. The structure of the online questionnaire used in phase one

is explained in more detail in table 7 and was used to collect both types of data. It proved useful in gathering demographic information as well as the first year pre-service teaching students' computer attitudes and digital self-efficacy levels early on in my research. I then matched these to their baseline digital competence test results and identified students for further research in phase two. Only qualitative data obtained through the use of interviews was gathered in phase two. Phase two was a more intensive investigation into the smaller cohort of 28 students' lived experiences of coming to be digitally competent. It was in phase two that I began analysing my data and applying an analytical framework of actor network theory to my findings.

I provide details of my data collection procedures in table 5 below. I list the research questions that underpin my study in chapter one, but for ease of reference, I present them again here. The overarching question which my research aims to answer is:
What role do digital self-efficacy, computer attitude and other factors play in the development of digital competence in first year pre-service teachers at the HEI?
This entails consideration of the following sub-questions:

1. What are first year pre-service teaching students' perceptions of digital competence?
2. What are first year pre-service teaching students' current levels of digital competence?
3. What factors inhibit or afford the development of the first year pre-service teaching student's digital competence?
    a. What relationship is there (if any) between computer attitude and a student's attainment of digital competence?
    b. What role does a belief in one's own ability to use ICTs (self-efficacy) play in the development of digital competence?
4. How do first year pre-service teaching students come to be digitally competent?

Bearing the above questions in mind, table 5 below summarises the timeframe, data collection method and research population that I used to address each of the research questions.

I identify five main data collection instruments in table 5 below. These are the online questionnaire, computer attitude scale, digital self-efficacy scale, baseline digital competence test and the interviews. I discuss each of these instruments and the data collection technique they promoted in more detail in the following section.

Table 5: Data collection procedure

		Data collection method	Details	Who	Time frame	Addressing research question
Phase 1	1.	Questionnaire CAS Scale DSE Scale	Demographic, computer attitude and computer self-efficacy as well as what digital literacy means	All first year pre-service teaching students (2013 and 2014)	2 years	Q1, Q3
	2	Baseline digital competence test	Test determining the digital competence levels of the first year pre-service teaching students as they enter the HEI	All first year pre-service teaching students (2013 and 2014)	2 years	Q2
	3	Sub groups identified	Novice, intermediate and advanced ICT users	28 students	2 years	Q4
Phase 2	4a	Interviews	28 students interviewed over a two year period – qualitative details regarding the students' process of coming to be digitally competent obtained	Sub group of 28 students	2 years	Q1-Q4
	4b	Follow-up interviews	Follow-up interviews conducted with 9 students	9 students	2 years	Q1-Q4
	5	Data Analysis	Actor network theory lens applied to data findings	All students	1 year	Q1-Q4

3.3. Data collection techniques

Table 6 below, details the specific data collection techniques, research instruments and the research questions that the data-gathering techniques described above provide data on. The benefits and limitations of these methods and instruments are also discussed. Each of the data collection techniques listed in table 6 below are described in more detail in the section that follows after.

Table 6: Table detailing the data collection instruments – their benefits and limitations

Instruments/data gathering techniques & when they are used	Research question	Benefits of the instruments/ data-gathering techniques	Limitations of the instruments/ data-gathering techniques
Baseline digital competence assessment	Q1. What are first year pre-service teaching students' perceptions of digital literacy?	• The digital literacy levels of a large cohort of students can be established	• A reliable and culturally unbiased assessment may be difficult to find
Questionnaires	Q2. What are first year pre-service teaching students' current levels of digital competence? Q3. What factors inhibit or afford their development of digital competence?	• Questionnaires are quick and easy to use with large samples. • Anonymity can be ensured (Opie, 2004). • If well-structured, they are easier and less time consuming to analyse than interviews, field notes, etc. (Bell, 2005). • They are useful for fact-finding	• There can be self-report bias by the respondent (Cohen, Manion, & Morrison, 2000) • There is no opportunity for clarification of questions if the researcher is not there (Fraenkel and Wallen, 1990). • There can be no probing further to pursue interesting answers (Opie, 2004).
Scales Computer attitude scale Digital self-efficacy scale	Q3a. What relationship is there (if any) between computer attitude and a student's attainment of digital competence? Q3b. What role does a belief in one's own ability to use ICTs (self-efficacy) play in the development of digital competence?	• Used extensively in questionnaires as they allow for a fairly accurate assessment of beliefs or opinions (McMillan & Schumacher, 2006).	• One problem is that all the answers can be the same, making it difficult to differentiate between items (McMillan & Schumacher, 2006).
Interviews	Further detail on Q2, Q3a and Q3b Q4. How do first year pre-service teaching students come to be digitally competent?	• Interviews are flexible, allowing the researcher to probe for more detail and thus for unanticipated answers (Bell, 2005; Cohen, et al., 2000) • Interviews allow for richer and more spontaneous responses in which respondents can express their ideas, insights, expectations & feelings (Opie, 2004) • Non-verbal information, e.g. tone of voice, facial expression and hesitation, can provide information that may have been concealed in the written responses (Bell, 2005) • The respondent can ask for clarification (Bell, 2005) • The researcher can clear up misunderstandings, establish rapport (Cohen, et al., 2000)	• The subjective nature of this approach can affect the validity of the data collected and claims made by the researcher (Bell, 2005; Cohen, et al., 2000; McMillan & Schumacher, 2006) • Interviews are time consuming to conduct as well as to analyse (Bell, 2005) • The presence of the researcher may inhibit respondents so they do not say what they really think, affecting the validity of the results (Fraenkel & Wallen, 1990; McMillan & Schumacher, 2006) • Interviews require well-developed interpersonal skills (Opie, 2004)

3.3.1. Baseline digital competence test

A digital competence assessment was administered to all first year pre-service teaching students as they entered the HEI in 2013 and 2014. This test was used to establish their current digital competence levels and address research question two. I did not pilot the test as it was a compulsory test designed by the course presenters and administered by them as part of the courses. I had no involvement in the planning and design of the courses.

3.3.1.1. The 2013 course and baseline digital competence test

The 2013 course was an IT competence course component within the first year course New Literacies for Teachers (NLfT). An endorsement in IT Competence had to be obtained in order for the student to pass the NLfT course. Access to the IT Competence course was provided via an online course page and the students were encouraged to complete all the online tutorials. They were required to achieve a minimum of 60% in all the assessment components. It stated on the course's online home page that the students may attempt the assessments more than once until they had achieved a score of 60% in the assessment. If the student attempted the baseline test more than once, the highest mark obtained was accepted as their final mark for this section of the course. The following tutorials were to be completed:

- Computer Basics
- The Internet and the World Wide Web
- Productivity Programmes
- Computer Security and Privacy
- Digital Lifestyles

The course covered five generic ICT skills and concepts. The curriculum featured screen shots and simulations from Windows 8 and Microsoft Office 2013 to illustrate and provide hands-on examples. The **computer basics** tutorial introduced the students to the fundamentals of computing. This section explained the components of a computer, operating system basics and showed the students how to use a mouse and a keyboard. The second tutorial, t**he Internet, cloud services, and the World Wide Web** showed the students how to connect to the Internet, browse web pages, navigate web sites, use search engines, and exchange e-mail with others. The third tutorial dealt with **productivity programs.** The most common productivity software applications used in schools and at home were explored. The students were taught the fundamentals of word processing, spreadsheets, presentation

software, and databases. **Computer security and privacy** was the fourth tutorial and helped the students to identify various threats to their digital devices and the data stored on it. They explored ways to protect their ICTs from these threats and considered the ethical and legal issues related to Internet usage. In the **digital lifestyles** tutorial the students were introduced to new digital technologies, including digital audio, digital video, and digital photography. They explored how these and other computing technologies are creating new career opportunities and shaping the world we live in. Under each tutorial was a link to a bank of questions related to that specific module. Questions from this bank were randomly chosen for the baseline digital competence test. Students could go through these questions to help themselves prepare for the test. If the students had worked through the module tutorials they would have encountered the questions prior to the test. Finally the students took the **digital literacy certificate test.** This test consisted of 30 questions that covered key points from all five of the digital literacy tutorials.

The students were also required to demonstrate their competence in practical skills in Microsoft Word, Powerpoint and Excel. These were separate projects and the students needed 50% to pass these projects. This and the online assessment meant that the pass mark for the entire NLfT course was 60%. The students were given up until a specific date to complete and pass the online assessment. Should they not have taken the test or failed it, they were required to attend compulsory training sessions. This initial date was extended. In 2013, 514 students registered for the course. They were encouraged to work through the online course material and take the baseline test before April 2013. By the end of the year 479 had taken the test. As the students were able to retake the test as many times as they wished until they had achieved a mark they were happy with, it was difficult to collect the baseline digital competence test data until the end of the year. It was therefore difficult to identify students for phase two of my research. I was provided administrative rights to the online course hosted on SAKAI and I could track the students and their sometimes numerous attempts at retaking the test.

3.3.1.2. The 2014 course and baseline digital competence test

In 2014, the students took a different test and were required to obtain a 55% pass rate for the test. As mentioned previously, the new course designers in 2014 made changes to the course and the required pass mark. If they achieved 55% or above, they were exempt from attending the core lectures or training sessions. A link to the baseline test was provided on the

Computer Studies Endorsement homepage. The students that failed the baseline test were required to attend the compulsory face-to-face lectures. This ensured that the classes were kept small and the students that lacked the necessary skills would benefit as a result. Similar to the 2013 course, this course also covered; computer basics, the Internet and the World Wide Web. The Microsoft Office programmes of Excel, Word and Powerpoint were also covered. Social networking and computer security and privacy were addressed.

In 2014, 768 students registered for the course. They had to take the test in a one week window period. 660 students took the test during that one week. Fourteen students who took this test were interviewed in phase two of my research project. Collecting the data from this 2014 group was relatively easy as the students took the test in a one week window. After this I was provided with an Excel spreadsheet with each student's allocated mark from the baseline digital competence test. As a result I was able to quickly identify students to interview in phase two of my research.

3.3.1.3. Analysing the baseline digital competence test results

I used the baseline digital competence test to collect quantitative data. I recorded the baseline test results on a large spreadsheet. I present findings on the pass and failure rate of this baseline test in chapter five, table 22. Combining the baseline test results with the data obtained from the online questionnaire, described in the section below, enabled me to correlate variables. I could, for example, compare self-rated ICT ability, computer attitude, digital self-efficacy level, description of digital competence with the student's test result. I also identified the 28 students that I wanted to interview in phase two of my research. Of the 28 students I identified, ten failed the baseline test.

3.3.2 Survey – online questionnaire

Surveys are used in research to gather data from a group of people, or research sample at a particular point in time. In this way, existing conditions can be described. Characteristics, such as their opinions, beliefs, attitudes, knowledge and experiences can be presented (Cohen, Manion, & Morrison, 2007; Fraenkel & Wallen, 1990). A questionnaire in my study signifies the use of questions to elicit responses in a self-completion format in order to generate data. Such questionnaires are often used in mixed methods approach to promote objectivity, scale, breadth and generalisability (Scott & Morrison, 2007).

In addition to taking the compulsory baseline test, I invited all first year pre-service teaching students in both cohorts to voluntarily complete my online questionnaire. I designed and hosted my online questionnaire (appendix A) using the online survey tool - Survey Monkey for two years. It was available via a link on the NlfT course home page (2013) and the Computer Studies Endorsement home page (2014). The students were required to visit these course home pages as a course requirement as this was where they received their assignments, tutorials and study material. I did not want to disadvantage novice ICT users, so I had paper copies of the questionnaire available. No student used these in either of the two years the data was collected.

I designed the questionnaire in an online format as it would appeal to the students to take it online and make data collection and analysis of the results easier. One hundred and twenty-four students (cohort one 2013) and 252 students (cohort two 2014) completed the online questionnaire. Of these only 86 (cohort one) and 221 (cohort two) questionnaires were fully completed and the rest were discarded. I provide a rationale for each of the questions and sections in the online questionnaire in table 7 below.

As can be seen in table 7 below, my first question to the students asked for demographic and background information, namely their name, age, home language including what other languages they spoke. I provided the 11 official South African languages and provided a box for them to type any other language that may not be one of the 11 official languages. They detailed the following other languages: Italian (2), Korean (1), Gujariti (1), Cantonese (1), Portuguese (1), isiBhaca (1). I also asked the students which year they matriculated in to determine if they had any work experience prior to entering the HEI or if they were entering directly from matriculating from high school. The students were provided with a number of options when asked which digital devices they owned. These included; a desktop computer, laptop, tablet device like an ipad, kindle or other e-reader, ipod or MP3 player. I also asked whether they owned a gaming device such as a Wii, Xbox or Playstation. As a mobile phone is an ICT device owned by most students I felt it pertinent to establish what they used their mobile phone for. Firstly, I asked whether they owned a mobile phone. Secondly, I asked whether they used it to just make calls; make calls and send text messages; or make calls, send text messages and access the Internet. The final option included the above, as well as online banking or downloading of music and videos. I included an option whereby the students could detail anything else that they used their mobile phone for.

Table 7: Rationale for phase one survey questions in online questionnaire

Survey question	Research questions addressed	Rationale for question – theoretical framework
1. Demographic information		
1.1 Name 1.2 Age 1.3 Home language and other languages 1.4 Year matriculated	None	Students provide demographic information for research purposes and identify themselves so I can follow up with them in phase 2.
2. Previous experience with ICTs		
2.1 Ownership of ICT device 2.2 Ownership and usage of mobile phone – calls, sms, Internet searching etc. 2.3 Description of own ICT ability – novice, beginner, intermediate, advanced 2.4 Description of own Internet ability – novice, beginner, intermediate, advanced	2	Helps to identify who has access to ICTs and details their previous experience with ICTs and the Internet.
3. Digital Literacy		
3.1 Definition of digital literacy 3.2 Do you want to become digitally literate? Why or why not? 3.3 Who will teach you to become digitally literate? 3.4 What are you using to help yourself become digitally literate?	1 and 4	3.1 Formulate a definition of digital competence from the students' perspectives. Supplement what the literature says. 3.2 – 3.4 More information about the development of digital competence.
4. Factors – barriers or enablers (internal and external)		
4.1 What makes it difficult for you to use ICTs? 4.2 What makes it easy for you to use ICTs?	3	Identify internal and external barriers and enablers to development of digital competence.
5. Scales		
5.1 Loyd and Gressard Computer Attitude Scale 5.2 Murphy Digital Self-efficacy scale	3a and 3b	Provides quantitative data on students' levels of digital self-efficacy and their computer attitude.

The second set of questions was concerned with the students' previous experience with and access to ICTs. I asked them to choose from four choices to describe their current ability in using ICTs. They selected from the following options: *I have never used it before, I am a beginner user, I am an intermediate user* or *I am an advanced user*. The same four choices were indicated in the question that asked the students to describe their current Internet ability.

The series of questions on digital literacy in question three provided me information on what the students understood digital literacy to mean. I used the term digital literacy rather than digital competence in my questions to the students as they were more likely to have heard the term digital literacy before. I used these findings in chapter five to formulate a definition of digital competence that was relevant to the first year pre-service teaching students, and not necessarily one defined by the literature. I used the definition framework that I designed in subsequent chapter five to assist me in this process. In the online questionnaire I also asked the students whether they wanted to become more digitally literate and why they answered yes, no or maybe to this question. I was interested in finding out who and what was helping them become digitally competent. I assumed that if they answered "themselves", then they would have a good computer attitude and strong belief in their own ability. Following on from this I asked them what they were using to help themselves develop this competence in ICT usage.

Key to my research was the barriers or enablers that students faced when accessing ICTs. Numerous ones are identified in the literature. I wanted to establish which were specific to the South African context of first year pre-service teaching students registered at the HEI in 2013 and 2014. These factors could be either external or internal.

Finally in the online questionnaire, I included two scales. The first one investigated the students' computer attitudes. The second digital self-efficacy scale investigated the students' beliefs in their own ICT abilities. These were quantitative scales and each established a final numerical value. The data obtained from the two scales was used to address research question three. Each of these scales is discussed in more detail below.

3.3.2.1. Loyd and Gressard Computer Attitude Scale (Appendix B)

Computer attitude has been identified in the literature as a possible barrier or enabler to effective ICT use. In order to understand the extent to which this factor is present amongst individuals, it is essential to be able to measure the levels at which it exists (Blignaut, 2006). Computer Attitude Scales began to increase in the early 1980's following the launch of the first personal computer in 1978 (Garland & Noyes, 2007). Humans are normally fearful of anything new and understandably were fearful of this new technology and the concept of technophobia emerged. With this, emerged the need to assess and measure peoples' attitudes towards the technology to identify the problems and establish solutions.

First instruments date back to 1966 and although the technology has developed over the last 45 years, the humans who utilise them have not (Shaft, Sharfman, & Wu, 2004). People who have not had access to digital devices before may still feel threatened. Blignaut (2006) argues that even though some of the research he quotes dates back several years, since they address the human side of information technology, they are still applicable today. I suggest that tried and tested scales can be adapted and updated for use with today's generation. We are still trying to measure the same thing – human attitude. The technology may have changed and some may argue that the people have changed, but the way we assess their attitude has not.

Blignaut (2006) highlights in his South African study on the effects of computer anxiety and Internet attitude on computer self-efficacy, that instruments are available in the literature but they may not necessarily be applicable to people with a different mother tongue and educational profile than that of the original survey group. He states that negatively worded items in the scale can be responsible for inconsistent findings. However, he does point out that computer attitude and computer anxiety, are two determining constructs of success with computer related work. He goes on to say that if computer attitude is improved and computer anxiety minimised, performance will improve (Blignaut, 2006; Blignaut, Burger, McDonald, & Tolmie, 2005). Kay (1993) notes that favourable attitudes, as well as a strong belief in one's ability to work with computers, are necessary but not sufficient to ensure the development of a digitally competent student (Kay, 1993). When analysing the results I kept in mind that the reliability of the students' responses in the scales may be affected by the negatively worded items.

Gardner, et al. (1993), state that Loyd and Gressard's Computer Attitude Scale (CAS) is the best documented scale, and they suggest that it may be developing into a standard measure of anxiety, computer liking and confidence (Gardner, Discenza, & Dukes, 1993). Kutluca and Gokalp (2011) state that it is the most extensively used scale (Kutluca & Gokalp, 2011). According to Gressard and Loyd (1986), this scale is a convenient, reliable and valid measure of computer attitudes, which can be confidently and effectively utilised in research and programme evaluation contexts (Busch, 1995; Gressard & Loyd, 1986). Woodrow (1991) compared four computer attitude scales and suggested that the Loyd and Gressard's CAS gave a reliable measure of attitudes towards computers and their use (Woodrow, 1991). Gardner, Discenza and Dukes (1993) compared the CAS with three other computer attitude

scales and recommended that CAS be used for research if it contains subscales measuring the constructs of usefulness (Gardner, et al., 1993).

The Computer Attitude Scale (CAS) original format (1984), was revised by Brenda Loyd and Douglas Loyd in 1985 when they added the subscale; computer usefulness. The scale now comprises of four components: *Computer anxiety*, or fear, refers to a negative emotional reaction to the use or anticipated use of computers. This involves fear and apprehension, hostility, or desire to withdraw from the anxiety provoking situation. *Computer liking* refers to the liking of computers or enjoyment of working with computers, including the ability to solve problems with computers. *Computer confidence* refers to how the individual feels about taking a computer course, learning new programmes or other advanced tools, and using computers in general (Mizrachi & Shoham, 2004). *Computer usefulness* refers to how useful the individual feels the computer is to their work and personal life.

In a 1985 study that was concerned with the reliability, factorial reliability and the differential validity of the computer attitude scale, Loyd and Gressard evaluated 114 teachers' attitudes towards computer use in a microcomputer staff development course. They tested the reliability of their scale and a high reliability coefficient score of each subscale was established at computer anxiety, .90, computer confidence, .89, computer liking, .89 and computer usefulness, .82. The closer to one, the more reliable the scale. This measures the accuracy of an instrument by measuring the same individuals twice and computing the correlation of the two sets of measures. A total score of .95 was recorded when all four sections were used together (Loyd & Gressard, 1985). A high internal reliability of the CAS has been established and I felt confident using it in my research. The CAS has been used successfully in numerous studies, is easy to administer and for the students to understand and complete. The results provided were simple to understand and related to my research.

There are numerous studies similar to my own that have used and validated the Loyd and Gressard Computer Attitude scale or a translation thereof. These include a study made by Kutluca in 2010 examining the status of computer usage and attitudes towards computers of teachers in Turkey. Variables on their attitudes were also investigated (Kutluca, 2010). He conducted a similar study this time involving pre-service pre-school teachers (Kutluca & Gokalp, 2011). Metin and colleagues conducted another Turkish study involving pre-service teachers employing the CAS in 2012 (Metin, Yilmaz, Coskun, & Birisci, 2012). Another study that investigated the computer attitudes of teachers involved secondary teachers in

Nigeria. Ogunkola and Olatoye (2009) were interested in establishing the relationship between a teacher's computer attitude and their literacy level (Ogunkola & Olatoye, 2009). Some of the older studies that have also used the CAS to measure computer attitude in their research include Berberoglu & Calikoglu (1992), Farkas & Murthy (2005), Khorrami-Arani (2001), Yushau (2006) and Francis et al. (2000). High reliability, internal consistency scores and stable factorial validity of the CAS have been reported by Christensen & Knezek (1996), Nash & Moroz (1997) and Woodrow (1992).

In the CAS, a series of statements were presented to the student. Of the 40 statements of attitudes towards computers, 20 were negatively worded and 20 were positive. Each of the four subscales contained ten questions distributed evenly throughout the instrument. The students checked whether they strongly agreed, slightly agreed, slightly disagreed or strongly disagreed with each statement. The items were coded so that the higher the score, the more positive the attitude. The lowest score possible was 40 which indicated a negative attitude towards computers, whereas the highest score possible was 160. I made one change to the CAS. Statement 19 read: *When there is a problem with a computer run that I can't immediately solve, I would stick with it until I have the answer.* I changed the word "run" to "task". It now read: *When there is a problem with a computer task that I can't immediately solve, I would stick with it until I have the answer.* This change made the statement more understandable and relevant to the way that the first year pre-service teaching students in my research spoke about working with a computer.

3.3.2.2. Murphy Digital Self-Efficacy Scale (Appendix C)

Digital competence is not the same thing as digital self-efficacy. Digital self-efficacy is not a skill, ability or competence, but rather, it is a belief in one's own ability to use ICTs. Owen (1996) suggests that self-efficacy can be easily measured and that it can be used to assess a combination of affect, cognition and performance. In order to develop an instrument, a clearly defined set of skills or behaviours have to be identified (Owen, 1986). The difficulty with using existing computer self-efficacy scales is the need to replace items associated with outdated technology, such as computer diskettes and CD ROMs. There is a need to consider proliferation of Web 2.0 and Internet skills (Teo & Koh, 2010). I used the Murphy Digital Self-Efficacy (DSE) scale as it had clearly set out basic computer skills covering word processing, spreadsheeting, Internet usage and basic file management.

The Murphy Digital Self-Efficacy Scale (DSE) or an adapted version has been used in numerous studies. Delcourt and Kinzie used it in their 1991 (published in 1993) study of 328 undergraduate and postgraduate American university students enrolled in education courses. They measured what sorts of attitudes and perceptions of competence are encouraged by teacher education programmes (Delcourt & Kinzie, 1991). Ertmer and his fellow researchers employed the scale in a study of 32 students using computer applications in physical education. They looked specifically at the effects of experience on attitudes towards computers and judgements of confidence or self-efficacy (Ertmer, Evenbeck, Cennamo, & Lehman, 1994). Zhang and Espinoza also administered a computer self-efficacy scale to 224 undergraduate students at the beginning and end of an introductory computer course (Zhang & Espinoza, 1998). Similar to my research, some of these studies involved undergraduate students (Karsten & Roth, 1998a, 1998b; Qutami & Abu-Jaber, 1997; Sam, Othman, & Nordin, 2005) and some involve pre-service teachers in different countries (Delcourt & Kinzie, 1991). Fanni, et al (2013) conducted research on teachers' self-efficacy levels involving teachers in South Africa attending an ICT training course which was part of the Khanya initiative (Fanni, Rega, & Cantoni, 2013).

The scale consisted of 32 statements. Students indicated through the use of a five point Likert type scale the extent to which they agreed or disagreed with the ideas expressed, i.e. their level of confidence in completing each skill or task. The options were; strongly agree, slightly agree, neutral, slightly disagree and strongly disagree. The statements all began with *I feel confident…* and a digital skill followed on from this. The student indicated the level of confidence that they felt completing that task or demonstrating that particular skill. The lowest score possible was 32, which resulted from a student indicating that they strongly disagreed with every statement. This indicated a very low self-efficacy level or belief in one's own ability. The highest mark possible was 160, indicating a high confidence level.
I made changes to the DSE scale in order to make it more relevant to today's digital skills and my research population. Statement 6; *I feel confident handling a floppy disk correctly* was changed to *I feel confident handling a usb or portable storage device correctly.* I also changed the words *mainframe computer system* to *HEI server*. Statements 30 to 32 now read; logging onto the HEI server, working on the HEI server and logging off the HEI server. I did not feel it necessary to change any of the other statements. The statements were clear and suitable for a beginner computer user to answer and indicate their confidence level.

3.3.2.3. Piloting the questionnaire

I piloted a paper based version of the questionnaire with the first year pre-service teaching students of 2012. I added my questions onto the course co-ordinator's survey that she conducted with these students for her own teaching purposes. I analysed the findings and provided her with some interesting and relevant information for her own research. This course co-ordinator was different from the one in 2013 and the one in 2014. I physically captured 512 questionnaires in a spreadsheeting programme and used filtering and formulae to analyse the results. I realised the margin for error was greater when physically capturing the results. I also wanted to be able to identify the students for phase two of my research as quickly as possible and capturing the results took nearly eight weeks. I also identified questions that were ambiguous and needed amendment.

I reviewed the piloted questionnaire and in the final online questionnaire removed the option box "I can help myself" as a choice for the students when rating their own ICT ability. I removed this option as I decided that intermediate computer user and "I can help myself" were very similar. In the question that followed asking the students what they understood the term digital literacy to mean, I had included a follow-up question which asked how the students knew when someone was digitally literate. When transcribing their piloted responses, I noticed that their answers to these two questions were very similar and that it was repetitive to keep the follow-up question. As a result, I deleted the question in the final online questionnaire.

3.3.2.4. Collecting the online questionnaire data

I wanted the majority of the first year pre-service teaching students registered to take the online questionnaire. A link to the online Survey Monkey (an online survey hosting application) questionnaire was provided on the course homepage. In 2013, 124 students took the questionnaire. Of these I discarded 38 as they were incomplete. In an attempt to bolster the response rate, I recorded a video asking the students to participate in my research and placed it on the course home page. As I was a former colleague and not currently teaching on the course, I was appreciative of all the efforts the course presenters went to in encouraging the students to take the online questionnaire. As mentioned previously, in 2014, the students were asked to take the online questionnaire immediately after they had completed the baseline test in the one week window period. As a result the number of students who took the questionnaire in this year increased to 252. Of these, 31 were discarded as they were incomplete.

3.3.2.5. Analysing the data obtained from the online questionnaire responses

The online questionnaire was used to collect both quantitative and qualitative data. The data was returned to me via Survey Monkey in a spreadsheet format. Each student's name appeared in the first column and the relevant data e.g. their age, race, gender, previous ICT experience, home language was recorded in subsequent columns. I inserted a column and added the student's baseline test result. This data was used in the bar charts and tables shown in chapters five, six and seven. The students' qualitative responses to each questionnaire question were also listed in columns adjacent to the above demographic information. I allocated codes to commonalities of data that I discovered in my analysis thereof. I used this data in my discussion of my questionnaire findings in chapter's five to nine. I performed inter-rater reliability on all coding of data to ensure consistency of findings. A detailed account of my analysis method, and application of actor network theory, is provided in chapter four. The next stage of my research, phase two, involved case studies of an even smaller group of first year pre-service teaching students selected from the above group.

3.3.3. Case studies

Case studies are intensive descriptions and analyses of a bounded unit, in this case, first year pre-service teaching students' development of digital competence. As the hallmark of a case study is the investigation of naturally occurring situations in which variables are not controlled, the cases in my research are not artificially created as they may have been in an experimental research scenario (Scott & Morrison, 2007). The case study approach is an in-depth, holistic method of investigating a bounded contemporary phenomenon in a real-life context (Knobel & Lankshear, 1996). A qualitative case study approach enables the researcher to have a deep understanding of the reality. It provides a sense of `being there'. Such deep understanding in turn enables us to understand much about what will never be understood by other research strategies (Scott & Morrison, 2007).

In my research, the first year digital competence or ICT course, student attitude, barriers and self-efficacy were the 'bounded phenomenon", and the first year pre-service teaching students coming to be digitally competent at the HEI was the 'real-life' context. As the researcher, I investigated the phenomenon as it happened and worked towards generating a detailed, contextualised and multi-layered understanding of the student's engagement in all its forms. In this way, I used multiple case studies to generate thick descriptions of the particular phenomenon and to identify trends and patterns that could be useful for refining

theory and suggesting complexities for further investigation (Stake, 2000). I further investigated the barriers and enablers that students detail facing when accessing ICTs. I also looked at their computer attitudes and digital self-efficacy levels and their development of digital competence.

My research met the requirements of an educational case study as it was an empirical study conducted within a localised boundary of space, that being the HEI, and time, March 2013 to November 2014 (Scott & Morrison, 2007). In addition to this, it was conducted into interesting aspects of educational activity, that of first year pre-service teaching students coming to develop a certain degree of digital competence. It occurred in its natural context and within an ethic of respect for the research participants. Ultimately it was conducted in order to inform the decisions of the practitioners and the course designers. A good case study is one that gives the reader an extensive description of the case and its context and a few key issues which are presented so that the reader can appreciate the complexity of the case. These issues are drawn from a collection of instances in the data to detect issue-relevant meanings. Finally, I developed summaries or patterns or 'lessons learned' which are useful to the participants or to readers when applied to similar cases (McMillan & Schumacher, 2006).

Scott & Morrison specify that in order for a case study to be successful, it should be conducted in a way that sufficient data is collected for the researcher to explore significant features of the case and create plausible interpretations of what is found. As I detail below, I used various methods or tools to collect rich and varied data. Scott and Morrison state that the researcher also needs to be able to test the trustworthiness of these interpretations as well as constructing a worthwhile story. Lastly the researcher needs to relate the story to relevant research in the literature (Scott & Morrison, 2007). A case study approach is compatible with the interpretivist and explanatory framework in which my study was positioned as I sought to describe the phenomenon of coming to be digitally competent and analyse the students' descriptions of their experiences for commonalities and differences.

3.3.3.1. Case study approach and the interview sample

The site selected located the pre-service teaching students involved in a particular event – that of developing digital competence skills in their first year of study at a HEI in South Africa. There was a rich mixture of races, cultures, religions, home languages, ethnicities and socio-

economic status among the students in addition to their previous ICT experiences (Muller, 2009). For this reason, it was an ideal site for my research project.

In many educational studies non-probability sampling is used. This is a method that does not include any type of selection from a population, rather the researcher uses subjects who happen to be accessible (McMillan & Schumacher, 2006). In convenience sampling a group of participants is selected on the basis of being accessible as well as it being convenient to use the group as subjects. While this type of sample makes it easier to conduct the research, there is no precise way of generalising from the sample to any type of population. I am aware that the generalisability of my findings is limited to the characteristics of the sample involved in my research. My sample was a convenience sample as I interviewed students who were willing to participate in my research. My selection was also purposive, as I selected students with specific characteristics to further study. Many case studies use both quantitative and qualitative methods of data gathering and analysis to present a full picture of the phenomenon (Henning, et al., 2004). Interviews yield data of the participants' lived experiences, while survey questionnaires give more detail. My interest was in the process rather than the outcomes, in context rather than specific variables, in discovery rather than confirmation (Merriam, 1998). Using the quantitative baseline test results and answers to the online questionnaires, I identified a smaller group of students in each cohort. I emailed students who were 'interesting' to follow further. I specifically looked at their age – whether they were young or old. I was interested in interviewing some of the older students as well. I considered their race so as to have a demographically representative sample. I wanted to include students of different population groups and having different home languages in order to explore possible interactions of culture and home language on the student's network of learning. My sample was fairly racially representative of the general first year pre-service teaching intake, but lacked students in the Coloured and Asian population groups[9]. As mentioned previously, my selection was constrained by the students' willingness to participate in my research.

I also considered the students' responses to whether they were novice, beginner, intermediate or advanced ICT users in the online questionnaire. If the students mentioned a barrier or

[9] Statistics South Africa asks people to describe themselves in the census in terms of five racial population groups. The 2011 census figures for these categories were Black African at 79.2%, White at 8.9%, Coloured at 8.9%, Indian/Asian at 2.5%, and Other/Unspecified at 0.5%. http://www.southafrica.info/about/people/population.htm#.V-rBf_l97IU

enabler to their ICT use that was out of the ordinary, I also added them to my list. In 2013, I purposively initially identified 20 students of interest. Of these 12 indicated they would be prepared to participate in my further research. On setting up one on one interviews with them, only eight arrived. I then returned to my data and identified more students to approach. I was disappointed that some of the more intriguing cases did not arrive or were not prepared to participate further. I accepted that all research participation was voluntary and without compensation. I was relieved to have 14 students who were eager to assist.

The general rule in determining sample size is to obtain a sufficient number to provide a credible result (McMillan & Schumacher, 2006). This usually means obtaining as many as possible. As my study was primarily exploratory research, a smaller sample size was acceptable (McMillan & Schumacher, 2006). The second phase of my study comprised of rich descriptions of the 28 phase two students' experience of coming to be digitally competent captured through interviews. These descriptions were used to elucidate on the data gathered in phase one and inform question four as to how students came to be digitally competent in the first year Digital Literacy Online Computer Course endorsement in the NLfT course (2013) and in the first year Computer Endorsement course (2014).

In 2014, having learnt from my experiences of 2013, I identified a larger group from the start. While the students were eager to meet when I emailed and texted them, I experienced the same disappointment when they did not arrive for the scheduled interview. Subsequent emails and texts indicated that they had changed their minds or were now "just too busy". Not wanting to be overly persistent, I went back to my data and enlarged my pool of possible interviewees. I ultimately interviewed 14 students in 2014. The 28 phase two students interviewed showed the following characteristics:

Table 8: Background information of the 28 case studies – the students, their gender, race, age, home language, baseline test result and their digital ability

	Research Year	Pseudonym	Age	Gender	Race	Baseline Digital Literacy test	Home Language	Beginner, intermediate or advanced ICT user
1	2014	Aria	18	Female	Indian	pass	English	intermediate
2	2013	Beko	18	Female	African	pass	isiZulu	beginner
3	2013	Hex	18	Female	White	pass	English	intermediate
4	2014	Mandy	18	Female	African	fail	Sesotho	beginner
5	2013	Michelle	29	Female	White	pass	English	intermediate
6	2014	Dean	18	Male	African	fail	Siswati	intermediate
7	2013	Saul	20	Male	African	pass	Sesotho	intermediate
8	2014	Sarah	18	Female	African	fail	Xitsonga	beginner
9	2014	Nkateko	18	Male	African	fail	Xitsonga	intermediate
10	2013	Pumi	18	Female	African	pass	isiNdebele	intermediate
11	2013	Mina	18	Female	African	pass	English	intermediate
12	2013	Nona	22	Female	African	pass	isiBhaca	beginner
13	2014	Thandi	18	Female	African	pass	isiZulu	advanced
14	2014	Lee	17	Female	African	fail	English	beginner
15	2014	Bernatricia	18	Female	African	fail	Xitsonga	intermediate
16	2013	Angel	19	Female	African	fail	isiXhosa	beginner
17	2014	Nosheen	18	Female	Indian	pass	English	intermediate
18	2013	Margaret	19	Female	White	pass	Afrikaans	advanced
19	2013	Khomo	18	Female	African	pass	Sepedi	advanced
20	2014	Maym	18	Female	Indian	pass	English	beginner
21	2013	Peter	20	Male	African	pass	Sesotho	beginner
22	2014	Zanzi	18	Female	African	pass	isiZulu	intermediate
23	2014	Dennis	17	Male	African	fail	isiZulu	beginner
24	2014	Fisani	18	Female	African	fail	isiZulu	intermediate
25	2013	Devi	18	Female	Indian	pass	English	intermediate
26	2013	Ann	19	Female	Indian	pass	English	intermediate
27	2014	Rocky	18	Female	White	pass	English	advanced
28	2013	Zendzi	40	Female	African	fail	isiXhosa	beginner

In follow-up interviews, only nine of the students participated. As a result the convenience sample for my case studies was biased in a number of ways.

- I only approached all the students from the first year pre-service teaching group in 2013 and 2014 at the HEI.
- From these first year students, 86 students in 2013 and 221 students in 2014 fully completed the online questionnaire.
- 32 students were approached in 2013 and 40 students in 2014. Only 14 students were prepared to be interviewed in 2013 and 14 in 2014.

Despite this bias, the first year pre-service teaching students at the HEI provided rich and varied information.

There were five males and 23 females. The majority of the first year pre-service teaching intake was female. Ten of the students stated that they were beginner computer users, 14 intermediate and four advanced computer users. The oldest student was 40 and the youngest was 17. Table 9 below provides more information regarding the age of the 28 phase two case study students.

Table 9: Average, mean and median data regarding the age of the 28 case study students

Average age	19.5 years
Mode	18 years
Median age	18 years

Of the 28 students selected, 10 of them failed the baseline digital competence test. The highest result is 90% and the lowest is 40%. I spent three months in 2013 and four months in 2014 interviewing the phase two students.

3.3.4. Interviews

Human beings are complex and their lives are ever changing. As a result, the more methods used to study them, the better chance we have to gain some understanding of how they construct their lives and the stories they tell us about them (Fontana & Frey, 1998). While interviews form a key method of data collection in my research project, I remained mindful that "interviews are not neutral tools of data gathering but active interactions between two (or more) people leading to negotiated, contextually based results" (Fontana & Frey, 1998, p. 62). Educators frequently use interviewing to obtain multiple meanings of an experience (McMillan & Schumacher, 2006; Scott & Morrison, 2007). In the interviews I anticipated each individual providing a unique account of their process of coming to be digitally competent.

McMillan & Schumacher (2006) propose that the interview strategy employed should be a single long comprehensive interview with each person or three separate interviews with each of the individuals. I made use of a single long comprehensive interview. I encouraged the participants to respond open-endedly and to answer questions in their own terms. As I was looking for in-depth understandings about their experiences and a definition of the interviewee as a person who was actively constructing his or her own world, I relied heavily

on the interview text to supplement the quantitative data collected through the online questionnaire. The interview schedule is available in appendix E.

Reluctance or a general apathy to participate was noted in phase two. Mortality or attrition are terms that refer to the process whereby research participants drop out of a study. Attrition affects longitudinal studies and can be a threat to internal validity (McMillan & Schumacher, 2006). Emails and reminder cellphone texts were sent out to remind students of meeting dates. The identified students that agreed to meet for the interviews and then did not arrive did not negatively affect my research as I had identified others to interview. I interviewed 28 students over the two year period. The time frame for my study began on the 1st March 2013 and ended on 31st November 2014. In order to comply with ethical considerations, all students were invited to participate in the research project. They were asked to complete an informed consent form if they participated. No student was penalised in any way if they did not wish to participate and were able to withdraw from the study at any time. I used the data from the interviews to provide a narrative account of the students' experiences. I drew conclusions as to which factors affected their development of digital competence. In particular, the effect that student computer attitude and self-efficacy had on the development of digital competence was explored.

3.3.4.1. Designing the interview instrument

Interviews range in design along a continuum from formal structured interviews to completely informal unstructured interviews. Interviews in qualitative studies are essentially vocal questionnaires (McMillan & Schumacher, 2006). The highly structured end pays close attention to the task of collecting large amounts of data, in as focused a way as possible. The more informal or semi-structured interviews encourage interviewees to respond open-endedly (May, 1993). Purposes determine different approaches to the collection, management and analysis of the verbal responses that are referred to as data (Silverman, 2001). Interviews vary in relation to the degree of structure, interview purposes and length, depth and range, relationships between the interviewer and interviewee and the locations in which interviews take place. However, most importantly, interviews vary in accordance with the philosophical starting points that underpin them (Scott & Morrison, 2007).

According to McMillan and Schumacher, qualitative interviews may take several forms: the informal conversational interview, the interview guide approach, and the standardised open-ended interview. The informal conversation form did not suit my research as in such a

format, the questions emerge from the immediate context and there are no predetermined topics or wording. The interview guide approach was too unstructured for me as although topics are outlined in advance, the researcher decides on the sequence and wording during the interview (McMillan & Schumacher, 2006). As my interviews took place over a two year period, I wanted to ensure I had a structured interview format for reliability over the 28 interviews conducted. The standardised open-ended interview best served my purposes. It follows the assumption that if used methodically according to strict principles of objectivity and neutrality, that it will yield information that represents the reality more or less "as it is" through the responses of the participants. The data is regarded as credible and believable as long as the data is forthcoming without pollutants in a standardised procedure of non-interference from the interviewer (Henning, et al., 2004). Henning goes onto add that such a format is useful when conducting many interviews with different people. It may result in more reliable data and inter-subjectivity, which is the shared understanding of different subjects, may be achieved. I wanted to be a neutral facilitator who elicits forthcoming information from the students. There are criticisms levelled against the standardised interview. Some critics point out that the interaction and interplay between two people (the interviewer and the interviewee) cannot be seen as a reality in and of itself, but rather as a neutral and even clinical instrument. While such a clinical instrument may conjure up images of objectivity, this instrument is designed by a researcher who has his or her own view of the world and their own ontological position (Henning, 1995; Kvale, 1996).

Merriam points out that in semi-structured interviews, the interviewer can modify the sequence of questions, change the wording, and add to and explain the questions (Merriam, 2009), While I used an open-ended question strategy, I chose not to use a semi-structured interview format when designing my interview guide, but rather a standardised open-ended interview (McMillan & Schumacher, 2006). Participants were asked the same questions in the same order, thus reducing interviewer flexibility. The exact wording and sequence of the completely open-ended questions were predetermined. One of the disadvantages of this standardised wording of questions could be the constraining and limiting of the naturalness and relevancy of the responses. I view the standardisation as an advantage, especially after my piloting, where I found I was inclined to put words in the participants' mouths. I did not want to change the order of the questions or the wording thereof as I did not want the students to encounter the questions in different ways. I felt that the 28 interviews had more validity if

the exact same questions were presented in the same order. In this way I could ensure that all the questions had been answered.

This standardised open-ended interview format (McMillan & Schumacher, 2006) allowed me to pursue my interpretivist position. I planned my open-ended questions in advance which provided for rich and spontaneous responses from the students. I hoped the students would express their own ideas, insights and personal feelings in these interviews. Scott and Morrison list the key issue and purposes for semi-structured interviews as being the requirement of the interviewer to define the interviewee as a person who is actively constructing his or her own world, and to draw upon the interview text to develop insights into such worlds (Scott & Morrison, 2007). This is in line with my interpretivist framework of students constructing their own reality and the purpose of my interviews as gaining insight into the students' descriptions of their previous experiences with ICTs and their account of coming to be digitally competent. I relied on the structure of and standardisation of McMillan and Schumacher's standardised open-ended interview approach and the objectivity and neutrality of Henning's conventional standardised interview format to promote continuity and reliability of my interview questions over the two year period.

In designing the questions, I kept certain factors in mind. Standardised open-ended questions have no choices from which the respondent selects an answer. The questions need to be phrased for individual responses. Even though the questions are open-ended, they still need to be fairly specific in their intent (McMillan & Schumacher, 2006). I attempted to ensure the questions were not ambiguous in any way. After piloting the interview in 2012, any leading questions were rephrased. Even though I took extreme care in my design of the questions, as discussed after table 10, there were certain questions that were superfluous and could be omitted. There were also questions that I thought would elicit certain information, but did not. I thought about the way my own personal characteristics and bias may influence the responses. For this reason, I tried to not speak too much, unless I was asked to clarify a question. I asked the same questions in the same order in all 28 interviews.

The interview guide appears in Appendix E. The interview questions expanded on the questions asked in the online questionnaire and explored the students' perceptions of how they came to be digitally competent. The rationale for these questions is provided in table 10 below. McMillan and Schumacher identify six types of interview questions. My questions covered three of these different types. *Experience or behaviour questions* such as 1, 2, 6, 8

and 11 in my interview schedule elicited what an individual does or has done. *Opinion and value questions* such as 3, 4, 9, 10, 12 and 14 provided information about what the individual thought about his or her experiences. These questions revealed an individual's intentions, goals and values. *Questions about feelings* such as 5, 7 and 13, elicited how a person reacted emotionally to his or her experiences. *Demographic questions* in the online questionnaire produced routine information such as age, race, gender and therefore are not repeated here. I did not ask any *knowledge questions* which elicit factual information the individual has. I also did not ask any *sensory questions* regarding the individual's descriptions of what and how he or she sees, hears, touches, tastes and smells in the world (McMillan & Schumacher, 2006).

In preparation for the interviews I made a couple of notes regarding each student's demographic details and their result in the baseline digital literacy test, in addition to their DSE and CAS results. I explained to the students that the term ICTs was broad and covered a number of technological devices including computers, laptops, mobile phones and iPads. My first question to the students concerned their previous experience with ICTs. I probed how often they used the device and for what purpose. The second question followed on from this first one and enquired whether the HEI was the first time that they were using ICTs, specifically a computer. If they answered yes, I asked why they had not used one before. In question three, I enquired whether they felt they were forced by others to improve their ICT skills. If they answered yes, I questioned further to find out exactly who this was. The next set of questions related to their perceptions on what they felt made it difficult to use ICTs. This could include both internal and, or external factors. Following on from this, question five required the students to describe how they felt when using ICTs. I specifically wanted them to describe their emotions and qualify whether it was a negative or positive experience. Question six asked the student if they were teaching anyone else how to use a computer. The answer to this helped me better understand whether the student felt confident enough to act as a mentor to others in this area.

Table 10: Rationale for phase two interview questions

Interview questions	Research questions addressed	Rationale for question
Previous experience with ICTs		
1. Describe your experience with ICTs. How often do you use them and for what purpose? 2. Is this the first time you have used a computer? Why have you not used one before?	2 and 3	Helps to identify who has access to ICTs and details their previous experience with ICTs and the Internet.
Current experience with ICTs		
3. Are you forced by others to improve your ICT skills? Who?	2 and 3	Provides more information about current levels of digital competence as well as identification of a possible external barrier.
Barriers		
4. What makes it hard or difficult for you to use ICTs? 5. How do you feel when using ICTs? Describe your emotions. 7. Has your initial feeling towards ICTs changed?	3	Identifies internal and external barriers to development of digital competence.
Confidence		
6. Are you teaching anyone how to use ICTs?	3 and 4	Provides more information about the development of digital competence and digital self-efficacy and confidence.
Digital competence		
8. How have you come to be digitally literate?	4	More information obtained about the development of digital competence.
Internet skills versus computer skills		
9. Are your Internet skills better than your computer skills? If yes, why?	2	Establishes self-perceived current digital competence levels.
Computer attitude and digital self-efficacy		
10. Do you think having a positive attitude or belief in your own ability makes it easier for you to become digitally literate? 13. How do you feel about your own ability to use a computer?	3	Establishes how students felt about digital self-efficacy and their own digital competence. More information gathered to supplement CAS and DSE findings.
Current experience with ICTs at the HEI		
11. Are you attending the ICT lectures at the HEI? If not, why? 12. If you are attending these lectures, are they helping you? 14. Have your ICT skills improved since you arrived at the HEI? What can you do now that you could not do before?	2 and 4	Documents current engagement with ICTs at the HEI and development of digital competence.

I used question seven to gather information about whether the student's initial feeling towards ICTs had changed. This question needed further clarification during the interview process with a couple of the students not understanding what I was asking. I asked them whether they felt any different from when they sat down in front of a computer for the first

time, compared to now. Many of the students were then able to describe their feelings or emotions. This question expanded on question five which asked them to describe their emotions. After the first couple of interviews I could have omitted this question as they both appeared to ask the students to describe their emotions. On further investigation I found that answers to question seven provided a justification for their emotions and the responses provided rich and relevant information that I used later in my research.

Question eight was significant to my research and asked the students to detail how they came to be digitally competent. I anticipated detailed responses but found that I needed a follow-up interview where I asked the students to list five steps that describe how they came to be digitally competent. These responses were easier to analyse and perhaps more valuable. Unfortunately only nine students participated in these follow-up interviews and I had to mainly work with the initial responses. I managed to code them effectively and glean some interesting and valuable information. Question nine was irrelevant and I regretted including it. I asked the students whether they felt that their Internet skills were better than their computer skills. I included this question as I thought the students would detail their Internet skills being better than their computer skills due to the ubiquity of mobile phones with Internet access. Findings from the online questionnaire revealed that 83% of the first year pre-service teaching students had WAP enabled mobile phones and 39% stated that their Internet skills were better than their computer skills. Even though I asked the students to clarify the reason for their answer, this question did not contribute to any relevant findings. As only one of the phase two students responded that their computer skills were better than their Internet skills, I concluded that the students were able to access the Internet on their phones which accounted for them feeling they have superior Internet skills. More research beyond the scope of my study is required to draw credible conclusions.

Question 10 was too pre-emptive. I asked the students whether having a positive attitude or a strong belief in their own ability made it easier for them to become digitally literate. As I explained what my research was about prior to the interview, I felt that the students answered what they thought I wanted or needed to hear – that, yes, it was. Questions 11 and 12 involved their current experience with ICTs. I asked if they were attending the compulsory ICT lectures at HEI and if they were attending, whether they felt that the course was helping them. The second last question gathered information about how the students felt about their

own ability to use a computer. I supplemented the quantitative data gathered in the CAS and DSE scales in the online questionnaire with responses to this question.

My last question asked the students whether their ICT skills had improved since they arrived at the HEI. The obvious answer was yes, but what interested me more, was what they could now do that they could not do before. Finally before ending the interview, I invited the students to ask me any questions regarding my research. None took me up this offer. Nine of the 28 students interviewed in phase two participated in follow-up interviews. I asked the students five questions in the follow-up interview (appendix F). A rationale for these questions is provided in table 11 below.

Table 11: Rationale for phase two follow-up interview questions

Follow-up interview questions	Research questions addressed	Rationale for question
Confidence		
1. Do you feel more confident using ICTs than you did last year?	2 and 3	Introductory question to gauge student's current confidence and digital self-efficacy level.
Barriers		
2. You mentioned **B** being a barrier to your effective use of ICTs. Is this still the case? Is there any new factor that makes it difficult for you to use ICTs?	3	Describes internal and external barriers to development of digital competence.
Current computer skills		
3. You rated yourself as a **Y** computer user. Is this still the case?	2	Establishes self-rated current digital competence levels.
Digital competence		
4. What advice would you give to a first year pre-service teaching student entering the HEI who has never used a computer before? 5. Can you tell me in five steps how you came to be digitally literate?	4	Provides more information about the development of digital competence.

I included question one about the student's current confidence levels as an introductory question to gauge how they had progressed over the last year. The students who participated in the follow-up interviews were now in their second year of study. I noted what barrier the student previously mentioned as a barrier to their effective use of ICTs. I asked them whether this specific barrier still hindered them or whether there was a new barrier. I indicated this as **B** in table 11 above. I also asked the students if they still rated themselves as a novice, beginner, intermediate or advanced ICT user. I indicated the option as **Y** in table 11 above. Five of the students indicated that they had improved and four felt they were in the same category of use they initially indicated in the initial online questionnaire. Question four

encouraged the student to give a novice ICT user entering the HEI in their first year of study advice. In question five I asked the student to list the five steps they progressed through in becoming digitally competent. I included the last two questions as I felt they elicited responses valuable in answering research question four – how students came to be digitally competent.

3.3.4.2. Collecting the interview data

I piloted my interviewing techniques interviewing two first year pre-service teaching students in 2013 that did not form part of my phase two research group. The interviews had more questions and I tested my audio-recording device. I practised transcribing these interviews. I discovered when listening to the audio recordings and transcribing the interviews that I spoke too much. I prompted the participants too much and repeated what they said in my own words for clarification. I feel that I took too much control over the interview and decided that in the actual phase two interviews I would play a quieter and more passive role.

At the onset of conducting the interviews, I assured the student of confidentiality and establish some kind of rapport by asking the students how their studies were going and how they had settled into the HEI. I explained what my research involved and provided the students with an information sheet they could take home. This information sheet detailed my research, its benefits as well as my contact details should the students have any questions that they would like to contact me about (Appendix G). I told them that I found their questionnaire responses very interesting and had selected them to elaborate on these answers. I revealed that their responses were valuable to my research and would like them to share their personal experiences with ICTs and their process of coming to be digitally competent. I asked the students if they were comfortable with me audio-recording the interview and asked them to sign a consent form to be interviewed as well as audio-recorded (appendices H and I). I explained that there were no incorrect answers before I began the interview. I probed where necessary, but tried to keep this to a minimum as I did not want to repeat the mistakes I made in the pilot interviews where I prompted answers instead of objectively probing.

It was important to conduct the interview in a quiet venue, especially as I was audio-recording it. It also helped if the students were not distracted when I asked them questions. There were four students that I conducted interviews with in the corridor outside the computer lab, as the lab was locked. Otherwise all the other interviews were conducted inside an empty computer lab with both myself and the student seated on chairs at a desk.

The interviews took place in the afternoons at a negotiated time between myself and the student. I felt that at times the participants were rushing to their next class or even home, especially if it was a particularly late afternoon interview. This may have affected the quality and extent of their responses. The interviews consisted of 14 questions and took between 10 and 20 minutes. If the student did not understand the question, I rephrased it without changing the meaning of the question. The length of the actual interview was influenced by the personality of the participant and their willingness to elaborate on their responses.

All the interviews were audiotaped with the student's permission. I used a small unobtrusive IPod touch. The recordings were clear which helped when it came to transcribing. I took down notes on a hardcopy version of the interview schedule while interviewing each student. Even though I did not necessarily refer back to these notes when transcribing the interviews from the audio-recording, I found that during the interview it gave me something constructive to do, rather than stare at the students and possibly make them feel uncomfortable. I contemplated having the interviews professionally transcribed. I decided that it would be more valuable to my research to transcribe them personally. I was then better able to immediately identify any key issues of importance in my research. As the interviews were conducted over a two year period, I transcribed the interviews within one week after conducting each interview. This ensured that the interview was fresh in my mind when transcribing. I did not anticipate the length of time that each interview would take to transcribe. I was grateful for my piloting experience as I now knew that transcribing a 20 minute interview could take up to two hours to fully transcribe. I ensured that I captured every word accurately, even repetitions of words as well as ums and aahs to ensure objectivity when I came to analysing the interview transcripts.

I described my positionality as a researcher in chapter one. Researcher effects such as language, accent, age, gender, race, ethnic origins, class, demeanour and even dress have an effect on how much information the participant is willing to divulge (Breakwell, 1995; McMillan & Schumacher, 2006). I am a white, middle-class English speaking female. These factors as well as those mentioned by Breakwell, et al. and McMillan and Schumacher, could have an impact on the length of the interviews as well as the depth of the participants' responses. None of the students were similar to me in any way. The students differed in all aspects of culture, home language, and age to me.

3.3.4.3. Analysing the interview data

McMillan and Schumacher (2006) identify subjectivity and bias as a potential disadvantage to interviews. They point out that since an interview involves one person talking with another, anonymity is not possible. Confidentiality can be stressed, but there is always the potential for faking or being less than forthright and candid, because the subjects may believe that sharing certain information is not in their best interest. This is something that I kept in mind when evaluating the interview responses (McMillan & Schumacher, 2006). The analysis of interview data reflects the epistemological and methodological purposes of the research, in order to arrive at conceptual and theoretical coherence (Scott & Morrison, 2007). As interviews demand much of the researcher in terms of sensitivity and ethical awareness (Pole & Morrison, 2003), I conducted and transcribed the interviews as neutrally and accurately as possible. I purchased a license for the data analysis software Atlas.ti. This is a computer program used in qualitative data analysis to help researchers uncover and analyse complex phenomena hidden in unstructured data. The researcher can locate, code and annotate findings in order to evaluate the importance of the relations between the findings.[10] The same 14 questions were asked in 28 interviews. This made correlation of answers quite simple once I devised a coding system for each data set.

The standardised open-ended interview is a quest for subjective versions of reality based on the notion that the instrument (the interview schedule, guide or protocol) and the analysis of the data are free of contamination for the most part. Henning et al. believe that interviews should not be analysed for content only. Other aspects of discourse analysis should always be included in order to highlight possible hidden meanings that were created during the process (Henning, et al., 2004). The interviewer should be seen as someone who does not give information, but rather as someone who accounts for his or her information. This means that while the interviewer is formulating each and every response, they account for their position in society and specifically their position and experience with regard to the research topic (Henning, et al., 2004). As I converted the data into patterns of meaning I kept in mind that interpretative research is not aimed at gathering simple data. The way in which reality is accessed, systemised and organised changes the data (Henning, et al., 2004).

Once the recorded interviews were converted to written text, codes were awarded to different segments or units of meaning. Processed data does not have the status of findings until the

[10] www.atlasti.com

themes have been discussed and argued to make a point, and the point that is to be made comes from the research question(s) (Henning, et al., 2004). Henning states that interpretivist research invites the interpretation of content as once the sets of data have been coded and categorised, the researcher is closer to seeing the overall picture. As I discuss further in chapter four, I applied a lens of actor network theory to my analysis of the data. This is similar to a grounded theory analysis, as I made a distinct effort to see relationships between different categories and themes and justify the positioning of certain data. Logical patterns are constructed by asking how one set of categories may illuminate another and how there may be explanations and clarifications of social processes and phenomena in the data (Henning, et al., 2004). Grounded theory has been criticised as the mere search and retrieval of coded segments. However, I saw that it could be successfully linked to an interpretivist approach as a key issue in grounded theory is knowing the data and coding it thoroughly. Identified concepts are grounded in the data thus opening the findings for scrutiny by others (Scott & Morrison, 2007). The analysis of quantitative data depends on a relationship between the researcher and the data. My data was more than mere coded information. As an educational and interpretivist researcher, I inserted myself into a continual process of meaning making in order to understand the students' development of digital competence. I analysed my research data to look for ways in which the students made meaning and for the frames that shaped that meaning (Henning, et al., 2004). I looked for commonalities in the factors that impacted on an individual student's effective use of ICTs in addition to analysing and describing the ways in which they came to be digitally competent.

It is in this process of establishing commonalities that I realised I needed to look further to find an analytical framework that took into account the networking effect of these barriers. Gough (2004), a science educator, urges educators to look more closely at the 'banal structures and simplistic textual practices' of education. Similar to my research, his interest is in the interpenetration of humans and things in the everyday. He suggests that we should begin by unpacking mundane everyday tasks to trace the seemingly infinite interconnectivities among things and people that hold together any action in a particular place and moment. He provides the example of making a cup of coffee, which connects simple human actions with water from a tap connected to a reservoir by miles of piping, to an electric kettle plugged into a plastic plate on a tiled wall into a complex grid and flow of electric power, poured into a coffee pot holding together bits of plastic, glass, screws, then to an aluminum mug, attached to an arm then lifted to a mouth containing a new dental crown…

and so on. Actor network theory (ANT) is a way of providing a representation of networks of practice, a learning *about* something, rather than a learning *of* something (Fenwick & Edwards, 2010).

I traced the interconnectivities of actors in a student's network of learning to be digitally competent. In chapter six, I used actor network theory to identify and categorise non-human actors that are considered to have enough impact on a student's actions into different types. The main non-human actors impacting on their development of digital competence were:

- Barrier of access (17% of the students identified this barrier)
- Software barriers, including software language (16%)
- Rapidly advancing technologies and hardware issues (10%)

The non-human actors of Internet access, time and finances were also identified by a few students. Human actors were phenomena such as poor typing skills (3%), technophobia (1%) and attitude (0.2%). These were fewer and less frequent than the non-human actors. Through identifying and then shifting the focus on nonhumans that surrounded the students under study in my research, the roles of things and their influences over the students learning activity – coming to be digital competent were highlighted. Inexperience, access, software and hardware issues could influence learning behaviour. ANT provides an interesting opportunity to rethink the importance of these and how they may affect the development of digital competence.

3.4. Rigour in my research

I attempted to ensure that both my quantitative and qualitative findings were trustworthy. To validate is to check for bias, for neglect, for lack of precision. In addition the researcher needs to question all procedures and decisions critically and then theorise. In theorising, the researcher looks for and addresses theoretical questions that arise throughout the process, not just those that arise at the end. Finally the researcher discusses and shares their research actions with peers (Henning, et al., 2004). In order for qualitative research to be considered trustworthy there are a number of factors that the researcher needs to pay attention to. These four criteria include credibility, transferability, dependability and confirmability (Lincoln & Guba, 1985).

- Credibility refers to confidence in the truth of the findings.
- Transferability involves showing that the findings can be applicable in other contexts.

- Dependability involves showing that the findings are consistent and could be repeated.
- Confirmability is the degree of neutrality or the extent to which the findings of a study are shaped by the respondents and not researcher bias, motivation, or interest (Denzin & Lincoln, 2005).

In qualitative research, Lincoln and Guba refer to these terms as internal validity, external validity, reliability and objectivity. Kvale (2002) also makes an argument for moving away from the trinity of reliability, validity and generalisation in support of Lincoln and Guba's (1985) ordinary language terms used to discuss the truth values of findings. These are terms that are more routinely used, namely; trustworthiness, credibility, dependability and confirmability (Henning, et al., 2004). I discuss each of the above four criteria in respect of my research.

3.4.1. Credibility or internal validity

The term validity means the degree to which scientific explanations of phenomena match reality. It refers to the truthfulness of the findings and conclusions. Explanations about these phenomena approximate what is reality or truth, and the degree to which my explanations are accurate comprises the validity of my research design. There are four types of design validity in quantitative research:

- Statistical conclusion validity refers to the appropriate use of statistical tests to determine whether purported relationships are a reflection of actual relationships.
- Internal validity focuses on the viability of causal links between the independent and dependent variables.
- Construct validity is a judgement about the extent to which interventions and measured variables actually represent targeted, theoretical, underlying psychological constructs and elements.
- External validity refers to the generalisability of the results and conclusions to other people and locations (McMillan & Schumacher, 2006).

Lincoln and Guba, interpret internal validity as being the credibility, believability or plausibility of the research findings and results. Contaminating variables that could have crept in and caused the findings and results need to be identified. They point out the need to make explicit the limitations of a study. Qualitative work is heavily embedded in real-life

situations, settings and circumstances. The data needs to "speak" to the findings. The researcher needs to ask themselves whether they have provided enough "rich, thick description" regarding the setting, programme, subjects, procedures, and interactions, so that the boundaries and parameters of the study are well specified (Lincoln & Guba, 1985). Credibility in qualitative research leads to the results of a qualitative study being believable and trustworthy. Shenton (2004) suggests a series of steps to ensure a credible qualitative study. These steps include: firstly using well-established research methods such as interviews, participant observations and document analysis. I used the established Loyd and Gressard computer attitude scale and Murphy's digital self-efficacy scale when collecting my quantitative data. I used semi-structured, open ended questions in my interview schedule and provided a rationale for both these questions and those used in the online questionnaire. The second step entailed developing an understanding of the organisation being studied for data collection. At the time of embarking on my research, I had been an employee at the HEI in the Educational Technology department for 12 years. Thereafter I was a student at the same institution. The third step advises on random sampling of individual study subjects. I made use of convenience sampling over a two year period of the first year pre-service teaching students at the HEI. As discussed earlier, I employed multiple research methods to study the same phenomena. This fourth step was ensured by making use of a mixed-methods approach. I used both qualitative and quantitative methods to collect my data. These research instruments were previously discussed in more detail in table 6 of this chapter.

The above technique is called triangulation (Shenton, 2004). It is the use of two or more methods of data collection in the study of human behaviour. This is the cross-validation among data sources, data collection strategies, time periods, and theoretical schemes. To find regularities in the data, the researcher compares different sources, situations, and methods to see whether the same pattern keeps recurring (McMillan & Schumacher, 2006). It indicates that by coming from various points or angles towards a "measured position", you find the true position (Henning, et al., 2004). Cross-checking the evidence by collecting different kinds of data about the same phenomenon makes validation possible and is known as triangulation (Scott & Morrison, 2007). By investigating different facets of a phenomenon a more holistic and rich account of the phenomenon can be provided (Scott & Morrison, 2007).

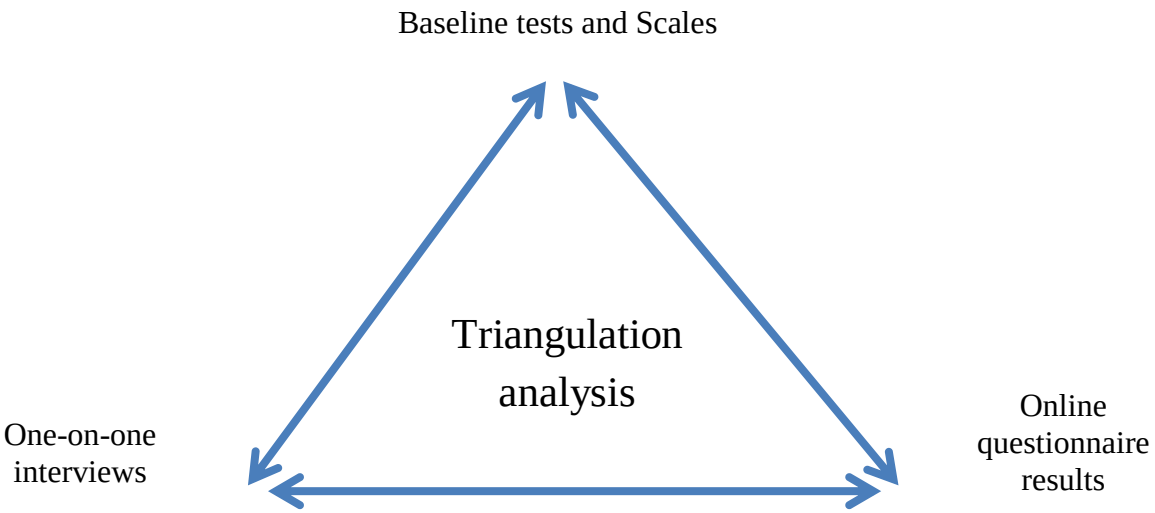


Figure 5: The triangulation process in my research

However, it does have more to do with interpreting and sourcing in various ways to build a complete picture than with calculating a position from three different vantage points. Multiple data collection methods are not without challenges, namely the issue of whether it is the same or a different phenomenon that is being researched. There is the chance that the evidence obtained by different methods produces contradictory findings (Bryman, 1988). Alternatives to triangulation have been suggested. Respondent validation involves the researcher's analysis of the data or transcribed interview being returned to the participant to confirm the factual accuracy of the account. I did not return my transcribed interviews to the students and did not provide them with access to the quantitative data. However, they did find out their result for the baseline digital competence test.

By using both quantitative methods (online questionnaire and scales) and qualitative methods (interviews), I used more than one method to study the same aspect of human behaviour. Did what the students indicate in their online questionnaire responses correlate with what they said during their one-on-one interview? For example, when I asked the students what barriers they faced when accessing ICTs, some responses in the online questionnaire differed from the response to the same question in their one-on-one interview. Nine of the 28 phase two students' responses were exactly the same and 19 differed. For example, four of the 28 students who initially listed access as an issue, no longer felt lack of access to ICTs was a factor in their learning. This may have been as a result of them now having consistent access to ICTs at the HEI. Nine of the students felt that they now no longer experienced any barriers to engaging successfully with ICTs. The interviews took place a couple of months after the

students completed the online questionnaire. Their engagement with ICTs and the first year course could have contributed to their altered responses to the question.

McMillan and Schumacher identify a number of threats to the internal validity or credibility of research. The ones I list below are ones I felt were pertinent to my research and include the following:

Subject attrition: occurs in a study when participants systematically drop out or are lost during the research process (McMillan & Schumacher, 2006). My research lasted for two years, and it was inevitable that students lost interest in the research and were not as eager to continue. This was evident in students not responding to invitations to follow-up interviews. Only nine students were involved in follow-up interviews. I did not find this too alarming as I had sufficient data from the initial interviews and the follow-up interviews were supplementary.

Researcher effects: are the deliberate and unintentional influences that the researcher may have on the participants (McMillan & Schumacher, 2006). This does not come into play during the quantitative data collection. The only time I needed to be aware of this was during my one-on-one interviews with the students. For this reason, I followed my interview schedule rigidly. I remained as professional as possible, but was cognisant that my age, gender, race, educational level and even dress may have affected the students' responses. I tried to minimise the possible impact that these uncontrollable factors may have had in the interviews and on my subsequent data collection. While establishing a definition of digital competence from the views of the students participating in this research, I minimised researcher subjectivity through the use of table 16. I developed this table in chapter five through comparing components of digital competence in the literature from various research views detailed in section 2.1.3. This coding table 16 was developed from Eshet-Alkalai's five literacy skills, Covello's six sub-disciplines of digital literacy, FutureLab's eight components of digital literacy, JISC and McHardy's seven elements of digital literacies and 21st Century skills. In table 28, in chapter five I list the barriers that students encounter when accessing ICTs. I then developed a framework table based on the barriers I identified in the literature. I map the barriers identified by the first year pre-service teaching students' responses in the online questionnaire to this information in table 29. Subsequently I map these barriers according to Darkenwald and Merriam's learning barrier categories in table 31.

Table 33 in chapter five, details the enablers that the students identified as promoting their interaction with ICTs.

Subject effects: In ideal research, the participants behave and respond naturally and honestly. However, when people become involved in research, they may change their behaviour simply because they now understand that they are subjects in a study (McMillan & Schumacher, 2006). These changes in behaviour are initiated by the participants themselves in response to the research situation. They may be inclined to present themselves in a positive light. This was an effect beyond my control, but remained a threat to bear in mind when interpreting my results.

3.4.2. Transferability or external validity

Transferability is the extent to which findings can be generalised to other settings. External validity refers to the generalisability of results. Transferability assumes a role similar to generalisation. Any transferability is the responsibility of the reader who seeks to make the application of theory elsewhere, and of the original researcher (Lincoln & Guba, 1985). My research of first year pre-service teaching students becoming digitally competent at the HEI allows the transfer of my findings internally to the bigger population of first year pre-service teaching students at the HEI. The degree of relatedness between the 28 phase two students in my research with the bigger HEI students' population varies as the first year pre-service teaching students are heterogeneous in many ways. They could be similar, or vastly different from each other. My findings do not provide a base for generalisation to other student populations across different higher education institutions as there could be vast similarities and differences between first year courses and programmes, across the country. Generalisation is dependent on the degree of relatedness and similarities of circumstances. The context between the first year pre-service teaching experience at the HEI and other pre-service teaching institutions dictates the transfer of knowledge from my research to another.

There is generally a de-emphasis on generalisability of findings in a case study but a whole-scale rejection is not necessary (Scott & Morrison, 2007). Therefore, it may be possible for the findings from my research to be generalised to other institutions with similar conditions and student populations or at least to future first year pre-service teaching students at the HEI. In qualitative research, there are two aspects of generalisability: *internal generalisability* within the community, group, or institution studied to persons, events, and settings that were not directly observed or interviewed: and *external generalisability* which refers to other

communities, groups, or institutions. Internal generalisability is far more important for qualitative case studies because qualitative researchers rarely make explicit claims about their external generalisability of their accounts. My research makes it possible for the HEI to better understand the first year pre-service teaching students coming to be digitally competent. In particular, my research findings allow the institution to reflect and address the barriers students may face such as access and prior inexperience. The first year computer competence course designers can improve the educational experiences of the first years in the future. Though the number of learners who participated in phase two of my research was small in number, my research allowed me as the researcher, and the HEI as the interested stakeholder to understand the students' perspectives and experiences on coming to be digitally competent at the institution.

Generalisation is supposed to be a major aim of educational research. Verma and Mallick debate this and ask the following questions: Is this always the case? Is generalisation the ultimate objective of educational research? Why do we always have to resort to generalising the research findings? Is generalisation always ever green and sustainable? (Verma & Mallick, 1999). Dzakiria views the ultimate aim of qualitative research as offering a perspective of a situation and providing well-written reports that reflect the researcher's ability to illustrate or describe the corresponding phenomenon. One of the greatest strengths of the qualitative approach is the richness and depth of explorations and descriptions. The mission of qualitative research, as I understand it, is to discover meaning and understanding, rather than to verify truth or predict outcomes (Dzakiria, 2006).

Verma and Mallick's questions about generalisability assume that theories are only built upon statistical inference. However, statistics are just one instrument to assist individuals to arrive at theories. Insightful findings in a case study is a theory in its own whether or not it is further developed to a theory about more cases. A theory which is well tested over one population does not necessarily apply to another population. In fact, Dzakiria points out that it is a common mistake to over generalise what is true in one educational research to other situations, contexts or even countries (Dzakiria, 2006).

Bassey talks about teachers and policy makers wanting clear statements like, *do x in y circumstances and z* ***will*** *be the result*. However, such straightforward statements are difficult to uphold. There are too many uncontrolled variables in the y circumstances. Bassey recognises that it is possible to make predictive statements such as *do x in y*

*circumstances and z **may** be the result*. He calls these statements fuzzy generalisations. The idea that it will also be true if you *do x in y circumstances and z may **not** be the result* needs to be embraced. Bassey believes that this can be overcome by making a best estimate of trustworthiness or BET. This is a professional judgement based on the experience and reading of the researcher expressed in a fuzzy form such as: *do x in y circumstances and z may be the case in between p and q % of instances*. To make a best estimate of trustworthiness, the researcher needs to think about the empirical findings of a research study in terms of who may use it and how useful it may be to them. Bassey suggests putting specific focus on the *y* circumstances and advises that this be the determinant of the population to whom the research applies (Bassey, 2000). My BET with regards the *y* circumstances, or the population to which my research findings apply is very specific. I am investigating the factors impacting on first year pre-service teaching students at the HEI network of learning to be digitally competent. My research findings are useful to course co-ordinators and presenters as I propose that if barriers to learning are minimised, the first year pre-service teaching student has a greater chance of becoming digitally competent. I ensured that I consistently reported on my findings being specific to this research population throughout my thesis.

While qualitative studies are not generalisable in the traditional sense of the word, nor do they claim to be, they can have other redeeming features which make them highly valuable in the education community. This can be achieved by extending the power to generalise to readers or other researchers through the concept of ***relatability*** (Dzakiria, 2006).

If X produces Y, and if Y is related to Z, do Y it may change Z

The key concept is the word 'related'. Relatedness is a prerequisite for any generalisations to take place. The reader asks the basic question of: is this research and its findings related my interest?, Circumstances?, Institutions?, and is it applicable, transferable? These basic questions ultimately help the reader to benefit or discard it as being not related and applicable to them. The concept of *relatability* steers away from grand generalisations. Rather than the researcher making generalisations based on the findings surfaced in a particular study, Dzakiria suggests that relatability leaves the act of making the grand generalisation to the readers or other researchers. If research findings are related to a particular organisation,

setting or circumstance, *y*, then the findings that surface may be related to *y*. The reader or other researcher(s) may then apply the findings to their situation (Dzakiria, 2006).

The researcher's task is to do the research well by describing the persons, places, happenings of the research in sufficient detail so that the readers can decide on the applicability of the experience to their own research or situation. Relatability entails the degree of relatedness on whether knowledge gained from one context is relevant to or applicable for other contexts, or the same context in another time frame. It assumes a role similar to generalisation. The act of making generalisation is the responsibility of the reader who seeks to make the application of theory elsewhere, and of the original researcher (Dzakiria, 2006).

3.4.3. Dependability or reliability

Reliability is used as a measure of quality and consistency (Scott & Morrison, 2007). Scott and Morrison advise that the object being measured remain stable in order to ensure reliability. They propose that a measure is reliable if it provides the same results on two or more separate occasions. The assumption is that the object being measured has not changed. The first year pre-service teaching students are aware that they are being studied and their participation is voluntary. In phase one (2013 and 2014), all the first year students completed a baseline digital competence test and were invited to complete an online questionnaire. This online questionnaire included the adapted computer attitude scale, and the adapted Murphy computer self-efficacy scale. As mentioned previously in this chapter, both of these scales had been analysed and tested in various other studies. They are standardised instruments for measuring computer attitude and digital self-efficacy in contexts similar to my research. They are commonly used in research pertaining to teachers and pre-service teachers as is my study. I acknowledge that when measuring human attitude there is a certain degree of individuality in responses as different students may have experience the same phenomena to different degrees.

To determine inter-rater reliability, a postgraduate Bachelor of Education Honours student also coded the data from the online questionnaire. I did this to examine the extent to which the way that I interpreted the information from the questionnaire was consistent. All the online questionnaires were coded by myself and the postgraduate student. The possibility of subjectivity came into play in the coding process. As a result, I used statistical measures to measure the inter-rater reliability in order to provide logistical proof that the similar answers collected were more than simple chance (Krippendorf, 2004). Explicit coding procedures that

could impact on the reliability of the coded data findings include a poor coding scheme, inadequate coder training, coder fatigue. I addressed these weaknesses by developing and testing simple coding schemes. I attended coding procedure workshops and rechecked my coding at multiple times and points.

Cohen's Kappa (1960) is a statistical measure determining inter-rater reliability (Cohen, 1960). I created contingency tables after I coded the data from the qualitative, open-ended responses to the questions I asked in my online questionnaire. The postgraduate student used my coding categories to recode the responses. If inter-rater reliability is not at the appropriate level, generally 0.7, then it is often recommended that the data be discarded (Krippendorf, 2004). The Kappa for the question that asked the students which barrier they encountered when accessing ICTs was 0.80 indicated a strong level of agreement. The Kappa for the question that asked the students what they felt enabled their effective use of ICTs was 0.83 indicating a strong level of agreement. The Kappa for the question which addressed the definition of digital literacy was 0.81 indicating a strong level of agreement between the two data raters. I asked the students who was teaching them to become digitally competent. The Kappa for this question was 0.81 indicating a strong level of agreement. Finally the Kappa for the question that asked the students what they were using to help them become digitally literate was 0.83 indicating a strong level of agreement between the coders.

I used an online statistical analysis software package, Statwing, to explore relationships between the variables in my data. I used Statwing to establish the descriptive analysis and Chi-square results of the data presented in tables 18 onwards. Chi-square is a nonparametric test used to answer questions about association or relationship based on frequencies of observations in categories. While parametric tests are concerned with estimating characteristics of the population, a nonparametric test, such as Chi-square, does not test hypotheses about the characteristics about a population. I used Chi-square tests to test the reliability of hypotheses about relationships between variables or phenomena in my research. It compares the reported, or observed, frequencies with theoretical or expected frequencies. The null hypothesis H_0 is tested. This is the status quo – that the frequencies in the two categories are the same (McMillan & Schumacher, 2006). If the P value is greater than 0.05, the null hypothesis is not rejected. If the P value is less than 0.05, then the null hypothesis is rejected and the alternative H_1 hypothesis is accepted. For example, I tested the statistical significance of the student's age and what they identified as a key component of digital

literacy. With a P value of 0.271, I did not reject my null hypothesis that there was no correlation between the two variables. Regardless of age, the majority of students identified functional skills as key to being digitally literate. I used Chi-square tests when analysing the data collected from the online questionnaire. Findings are presented under each respective table in chapters five, six and seven.

3.4.4. Confirmability or objectivity

Another strategy that assisted in judging the trustworthiness of my research and data was for me to critically reflect on myself as the primary instrument of research by stating my positionality (Merriam, 2009). I reflected on this at the end of the introductory chapter one. Peer review of research was also valuable. The HEI I study at held quarterly PhD weekends where researchers were able to present their current research findings. These fellow PhD candidates provided invaluable feedback on my research in progress.

Validity refers to the degree to which scientific explanations of phenomena match reality as well as to the truthfulness of the findings and conclusions (McMillan & Schumacher, 2006). It asks the question whether we are measuring what we are supposed to be measuring with the instruments. Ultimately – are we investigating what we say we are investigating (Henning, et al., 2004)? It was important that I continually checked for bias, for neglect and for lack of precision throughout my research. In addition, I critically questioned all procedures and designs, looked for and addressed theoretical questions that arose throughout this process (Henning, et al., 2004).

While I attempted to ensure that my research strategies remained consistent, the baseline digital competence test differed from 2013 to 2014 due to course design and co-ordinator changes. The pass mark from 2013 to 2014 also changed. However, the basic content of the test as well as the manner and format (multiple choice questions) in which it was administered remained constant. All the first year pre-service teaching students completed the same online questionnaire over the two years. Through using Survey Monkey to gather the student responses to the online questionnaires, margin for error and subjectivity in capturing the data was reduced. I transcribed the interview data word for word while listening to the audio recordings of the interviews. The interview questions remained constant and the manner in which I interacted with these students during the interview was consistent.

While my research was not an intervention in the students' experiences of and with ICTs, the mere fact that attention was drawn to the students' experiences may have led them to be more aware of their learning. They may have thought about how they were learning to use ICTs in a meta-cognitive manner and this may have impacted on their sharing of their personal experiences. This raised the concern of them "over-thinking" and justifying and judging the learning process instead of just detailing their experiences. This may have influenced their actual experiences and the way in which they perceived the learning process and altered their genuine discussion of their experiences (Smith, 1999, 2006). The students were not rewarded in any way and there was no benefit for them from participating in my research.

Advantages and disadvantages of self-evaluation exist and these are important to bear in mind in research such as mine in which some of the qualitative data was collected through self-evaluation. The possibility of not being able to recognise one's own incompetence may lead to inflated self-assessments. A student may over-estimate their own ability, also known as the Dunning-Kruger Effect and this has implications for the reliability of my scales (Kruger & Dunning, 1999). Self-evaluation instruments and questions used in my research included the CAS and DSE scales as well as a rating of one's own ICT and Internet usage ability. I found the student's self-rated ability to be reliable. When investigating the student's self-rated ICT ability and their baseline digital competence test result, there was a strong Chi-square correlation in the data contained in table 26 in chapter five. The students did not just click on any option, but thought about their answers.

3.4.5. Ethical Considerations

I applied for and obtained ethics approval (appendix K) from the HEI to proceed with my research. My application to the HEI Ethics committee included the aim of my research and the research questions. I provided all of the research instruments for approval. I detailed the methods that would be used, who would be participating as well as how confidentiality would be ensured. The Head of School at the HEI at the time also gave her permission for my research to be undertaken. The informed consent forms deal with the ethical aspects of the right to confidentiality, the right to not participate as well as honest, factual information about my research. This practitioner research better informs current practices at the HEI. A subject information form (appendix G) detailing the nature of my research was provided to all participating first year pre-service teaching students. All students signed an informed consent form (appendix H) permitting me to use their baseline test results and online questionnaire

responses in my research. They were free to withdraw from my research at any time and if they did not wish to participate, they were not penalised in any way. All pre-service teaching students enrolling at the HEI were required to complete a compulsory initial digital competence assessment. I asked the students to voluntarily complete the online questionnaire. While the online questionnaire was not anonymous, it was confidential. This was so a smaller group of students could be identified and interviewed in phase two. The phase two interviews were digitally recorded for accurate analysis of responses, and all participant names remained confidential. The students chose their own pseudonyms after the interview. In addition to the previously mentioned subject information form and informed consent form, the interviewed phase two students signed informed consent forms agreeing to being interviewed (appendix I) and audio recorded (appendix J).

I adopted an autocratic approach to the ethics of this educational research. I assumed full responsibility for the collection and subsequent reporting of data. In a more democratic approach, the researcher allows the participants the right to veto what is and what is not included in the research project (Scott & Morrison, 2007). A duty of an autocratic approach is the responsibility to protect the participants. I informed the participants of all aspects of my research that might have influenced their willingness to participate. I informed them that they may be contacted to participate in a one-on-one follow-up interview. I guaranteed their right to confidentiality. The online questionnaire and one-on-one interviews were not conducted anonymously, but I ensured confidentiality by being the only researcher that accessed this data prior to pseudonyms being allocated.

3.5. Concluding remarks

My research design consisted of two phases. Phase one was characterised by the collection of quantitative data through baseline digital competence tests and an online questionnaire hosted on the online survey hosting site – Survey Monkey. Employing a mixed-methods approach, I used qualitative tools to collect data that enriched my quantitative findings. I began chapter three by describing my philosophical position. I provided detail on the two first year ICT endorsement courses the first year pre-service teaching students attended. A rationale for each question in the online questionnaire was provided in table 7 in chapter three. In addition to demographic information, the responses to the online questions were used to enhance the quantitative data findings. I justified the use of two scales in the online questionnaire; the Loyd and Gressard computer attitude scale and the Murphy digital self-

efficacy scale. The scales gathered information about the students' computer attitudes and beliefs in their own digital abilities. The results from these scales were used to answer research question three which is explored in more detail in chapter seven. Within a case-study approach, I made use of semi-structured interviews. Twenty-eight students were interviewed in phase two. A rationale for the interview questions was provided in table 10. I concluded chapter three by detailing how I maintained rigour in my research and ensured my study met the ethical requirements of the HEI. In the following chapter four I present a detailed account of actor network theory and explain how I apply it as a lens to the analysis of my research findings.

Chapter 4 - Analytical Reasoning

In chapter four I detail the theoretical framework underpinning my research. I explain the actor network theory (ANT) approach I employ to analyse my research findings.

4.1. Theoretical framework

Research is the process of trying to gain a better understanding of the complexities of human experience, and in some genres of research, to take action based on that understanding (Marshall & Rossman, 1999). My research identified possible phenomena that acted as either enablers or barriers impacting on a first year pre-service teaching student coming to be digitally competent. The action that could be taken as a result is to reduce these phenomena or factors in order to enhance computer mastery in the future. In research, the aim of the researcher is to gather information about actions and interactions. The researcher then reflects on their meaning and arrives at and evaluates conclusions. Finally the researcher proposes an interpretation. My research explained, described and explored the phenomena, specifically computer attitude and digital self-efficacy as factors impacting on a student's network of learning to be digitally competent. The desired result was to bring about a better understanding of the phenomena and to change problematic social circumstances (Czerniewicz & Brown, 2009). The findings from my research are significant for future practice at the HEI.

Research needs to be framed in a larger theoretical domain in order to develop its significance. In this chapter I describe a theoretical framework that provides a means to document and explain the students' accounts of coming to be digitally competent. A theoretical framework provides a general representation of the relationship between the identified issue, that of coming to be digitally competent, and the phenomena that may impact positively or negatively on this. The more specific analytic framework provides a practical tool to help interpret the collected data. The two are different. The theoretical framework is overarching, whereas the analytical framework is a specific lens used to guide the analysis of my research results and findings.

In deciding on a theoretical framework, I focused on what the problem was that I intended researching – how students came to be digitally competent and the factors that may impact on this learning network. While exploring various theoretical frameworks, I remained cognisant

that the most appropriate one would be a framework that took into account the impact of various inter-related factors or phenomena on an outcome, namely the network of learning to be digitally competent. I developed the following four assumptions when designing my research instruments; - the interview schedule and the online questionnaire. These helped keep my preconceived ideas about the outcome of my research in the foreground. These were expectations that I hoped to either prove or challenge.

1. Students with high computer attitudes (CA) or strong digital self-efficacy (DSE) levels or both may be more digitally competent and were more likely to pass the initial baseline digital competence test
2. Students with high CA or DSE levels or both were more likely to achieve the desired level of digital competence within a shorter timespan than students with a low DSE or CA level or both
3. There were variables that could impact positively or negatively on student's DSE, CA levels or on both.
4. These variables may function in isolation but it was more likely that they are inter-related and impacted on each other.

The theoretical framework that underpins my study is an interpretive one. The analytical framework I used has strong links to principles of actor network theory. Figure 6 below summarises the frameworks supporting my research.

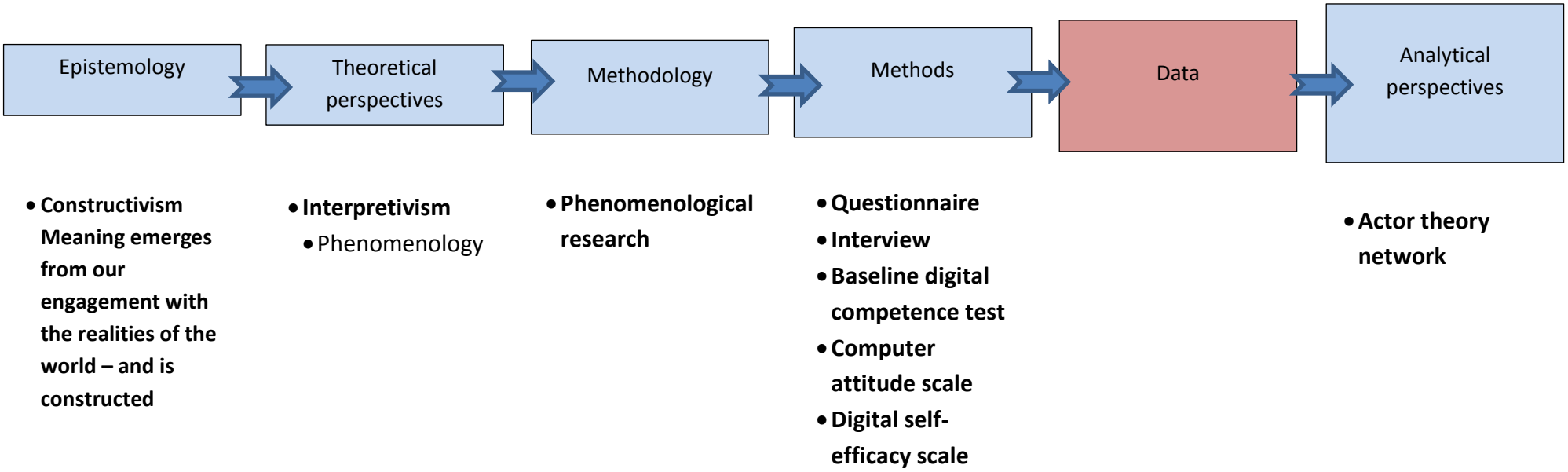


Figure 6: Diagram depicting the relationship between epistemology, theoretical perspectives, analytical perspectives, methodology and research methods (adapted from Crotty 1998).

At the onset of my investigation into theoretical frameworks I initially investigated a positivist approach. Such an approach is premised on the existence of a priori or previously existing fixed relationships within phenomena (Olikowski & Baroudi, 1991). The section that follows describes the process I followed in deciding on a final theoretical framework to guide my research.

4.1.1. Positivism

Here I expand on my brief description of Positivism in 3.1. where I discussed my personal philosophy and research paradigm. A positivist approach to research is based on knowledge gained from 'positive' verification of observable experience rather than, for example, introspection or intuition (Cohen & Crabtree, 2006). Positivist research is conducted for the purpose of predicting and explaining. Reality is seen as real and existing "out there" just waiting to be discovered. A positivist view is that the best way of achieving this knowledge is through scientific methods or experimental testing (Agheridien, 2007). A distance between the subjective biases of the researcher and the objective reality he or she studies must be ensured. Positivist researchers propose that there are general patterns of cause-and-effect that can be used as a basis for predicting and controlling natural phenomena. It is the researcher's aim to discover these patterns. Another belief is that we can rely on our perceptions (observations or measurements) of the world to provide us with accurate data. Research is value-free provided that strict methodological protocol is followed resulting in research that is free from subjective bias (Cohen & Crabtree, 2006).

Positivism is a theory building approach that assumes the existence of a "real," apprehendable reality driven by immutable natural laws and mechanisms. Positivist researchers are capable of studying objects without influencing them or being influenced by them (Guba & Lincoln, 1994). Knowledge is discovered and verified through observation rather than being situated in time and context (Agheridien, 2007). I wanted to adopt an approach that was more inductive and looked for emerging categories rather than a positivist, deductive approach that tested validities or proved hypotheses. The positivist approach views human behaviour as being determined by laws over which humans have little control. It is a reductionist approach in which individuals do not have their own realities (Agheridien, 2007). Positivism does not make allowance for the interpretations and understanding of context specific and unpredictable social factors such as feelings, beliefs and motivations. All of which I identified in my research and in the literature as impacting on a student's process of coming to be digitally competent. It cannot be adequately used to explain the trends and relationships between ICTs and such social phenomena. The conceptual framing of ICT issues such as those highlighted in my research cannot be effectively carried out using non-interpretive positivist paradigms such as predictive hypothesis testing and quantitative measures of variables (Klein & Myers, 1999). For the above reasons I decided that a positivist approach was not the most appropriate research approach for my investigation.

4.1.2. Interpretivism

The paradigm informing my research was one that took into account that becoming digitally competent was reliant on a number of underlying phenomena that may act in isolation but may also impact on each other. An interpretivist framework tries to present the reality of the participants from their own views and follows the premise that knowledge is constructed not only by observable phenomena, but also by descriptions of people's intentions, beliefs, values and reasons, meaning making and self-understanding (Henning, et al., 2004). The interpretivist researcher looks for frames that shape the meaning that participants make and remains extremely sensitive to the role of context (Henning, et al., 2004). This is reiterated by Giddens (1984a), as he describes the prioritisation of the construction and negotiation of meaningful activity by interpretivists.

I propose that the phenomena that individuals experience do not act in isolation, but rather impact on each other and may result in other phenomena. I explored students' perceptions, attitudes and self-efficacies in my research. These self-understandings and attitudes may have been a result of previous experiences with digital tools. This prior experience ultimately impacted on the barriers and enabling factors the students may have faced, and finally in the way they came to develop digital competence. As the students described their actual experiences within the context in which their learning experiences were taking place, drawbacks to such a paradigm needed to be investigated. An interpretivist approach in its purist form may be criticised for not taking into account the multi-perspectival nature of descriptions of social reality. In addition, it is also argued that it is not possible to re-describe someone else's reasons for their actions (Scott & Morrison, 2007). However, it is counter-argued that there are many successful in-depth studies that use self-reported accounts as the first phase in understanding educational processes and activities. In such a study the researcher may offer critical accounts of the individual's understanding of the processes and is normally likely to go beyond what they are told by the respondents (Scott & Morrison, 2007). The researcher may analyse and comment on what is initially told by the respondents. It was important for me to bear the above in mind when reporting on, analysing and interpreting the students' qualitative descriptions of their experiences of becoming digitally competent.

I use the word phenomena to indicate the factors or actors that may impact on an individual's experience of coming to be digitally competent. These phenomena may act as either barriers

or enablers to this process. The focus of my research was on understanding the individuals' experiences. One of several overlapping research methodologies that enable the researcher to examine the lived experiences of individuals is **phenomenology**. Phenomenology is a qualitative research approach characteristic of an interpretive framework. From this perspective all human actions are intentional in the sense that "consciousness is always consciousness of something. An object is always an object for someone. The object, in other words, cannot be described apart from the subject, nor can the subjects be adequately described apart from the object" (Crotty, 1998, p. 79). The purpose of a phenomenological approach is to describe one or more individual's experience. In my research I interviewed 28 first year pre-service teaching students and described and reported on their networks of learning to become digitally competent. The primary data-collection of phenomenology was in-depth interviews and it followed that the data collected should be analysed by listing significant statements. By determining the meaning of these statements, the researcher ultimately identifies the essence of the phenomenon. The narrative report focus involves a rich description of the essential or invariant structures. These being, the common characteristics of the experience (Creswell, 1998).

ICT research in the interpretative domain is based on the assumption that our knowledge of reality is gained only through social constructions such as language, consciousness, shared meanings, documents, tools and other artefacts (Kaplan & Maxwell, 1994). In my research some of the artefacts or phenomena identified in the literature and by the first year pre-service teaching students included; language, gender, race, age, culture, prior experience with ICTs, access to ICTs, technological issues such as software and viruses. I explored this idea of a network or mesh of phenomena impacting on a student's learning experience further. Reading further, I found that an actor theory network approach helped reveal the ways in which different goals and interests of people, as well as the intended purposes of technologies, objects and claims, and in my research; attitude, digital self-efficacy and other identified enablers and barriers, penetrated and transformed one another (Yasukawa, 2003). Through an actor theory network perspective, learning is viewed as an effect of the networks of humans and non-humans. Teaching is not simply about the relationship between humans, but rather about the networks of humans and things through which teaching and learning are translated. These things or non-humans also encompass attitudes and previous experiences. Teaching and learning do not exist and cannot be identified as separate from the networks through which they are enacted. They are not independent entities or processes, but

assemblages (Fenwick & Edwards, 2010). This idea of a network of phenomena coming together to result in learning encompassed and helped explain my notion of the many multi-faceted factors that impacted on a student's experience of coming to be digitally competent.

4.2. Employing an interpretivist theoretical framework

Any study, regardless of paradigm, has a theoretical framework that positions it. Such a framework directs the research design and the selection of literature to review. According to Mertens, a "researcher's theoretical orientation has implications for every decision made in the research process" (Mertens, 2005, p. 7). One's personal understanding and formal theory from the literature review help bring the question or the problematic issue into focus and raise it to a more general level. Research moves from an intriguing real-world observation or question to personal theory, to formal theory or concepts from the literature. All of these come together to frame a focus for the study (Marshall & Rossman, 1999).

As I mentioned previously, when deciding on a theoretical framework for my research, I focused on what the problem was that I was researching – namely, how first year pre-service teaching students came to be digitally competent and the factors that may impact on this. The most appropriate framework was one that took into account the impact of various inter-related factors or phenomena on the outcome of developing digitally competence. My research aimed to better understand the phenomenon from the perspective of the participants by hearing what they had to say about their experiences. An examination of the personal experiences of a small number of first year pre-service teachers afforded potentially useful insights on the participants' individual experiences, but the results cannot be generalised to all first year pre-service teaching teachers. As I discussed in chapter three, the findings and conclusions drawn from my research can rather be *related* to similar populations. The emphasis on gathering insights from an inside perspective suggest that an interpretive theoretical framework was suitable for my research. Other studies involving ICTs that employed an interpretive framework include a New Zealand study of 10 beginning teachers' experiences with ICTs in their first year of teaching (Elliot, 2011). Another study looks at fourth year pre-service science teachers' professional knowledge in using ICTs to support them in their teaching careers (Arnold, Padilla, & Tunhikorn, 2009).

I used an interpretive theory, namely phenomenology, in my research to create an organisational framework to identify the phenomena that influenced the ways in which

students came to be digitally competent. Such a framework allows the researcher to examine the ways in which individuals make sense of the social world.

4.2.1. Taking interpretivism and phenomenology further

I found that using a phenomenological method with an interpretivist theoretical framework was not enough. As mentioned in a critique of interpretivism, I needed to take into account the multi-perspectival nature of descriptions of social reality. I found my research was messy as numerous barriers and enablers impacted on each individual student's interaction with ICTs. Each student I interviewed had their own unique *story* of how they came to be digitally competent. As Fenwick and Edwards, state; if the world is messy, how are accounts of the world in research tidy (Fenwick & Edwards, 2010)? Actor network theory (ANT) analyses typically trace how all things that are taken to be natural, social or technical are more accurately some messy mix of these which are enacted in webs. ANT analyses also trace how these things associate and exercise force, and how they persist, decline and mutate. Nothing is given or anterior, including 'the human', 'the social', 'subjectivity', 'mind', 'the local', 'structures' and other categories commonly taken for granted in educational analyses (Fenwick & Edwards, 2010).

Despite its name, ANT is not a theory. Its proponents refer to it as a virtual 'cloud', continually moving, shrinking and stretching, dissolving in any attempt to grasp it firmly. It should not be applied like a theoretical technology. It can be used as a way to sense and draw nearer to a phenomenon. For educational researchers, ANT approaches can enact questions and phenomena in rich ways that discern messy objects, multiple overlapping worlds and apparent contradictions that are embedded in so many educational issues (Fenwick & Edwards, 2010). There are relatively few studies that have used ANT in educational research. I used it as a means to explain the multi-facetted barriers and enablers that students encountered as they came to be digitally competent. I explain how this approach enabled me to explain the ways that things came together, acted and became taken for granted, or black-boxed in chapter seven.

4.2.2. Investigating analytical frameworks within an interpretive paradigm

The analytical framework is my understanding on how the research problem is explored and provides a lens that can be used to analyse the data. I explored the relationship between the specific phenomena impacting on a student's development of digital competence. In chapter seven, I document and explain the impact that a student's attitude towards using ICTs and

their digital-self efficacy, has on their progression through the skill acquisition phases. As indicated in figure 7 below, I investigated three possible data analysis frameworks within an interpretive approach. These were actor network theory (ANT), activity theory (AT) and structuration theory. The discussion that follows explores these three options and explains my reasoning for adopting ANT.

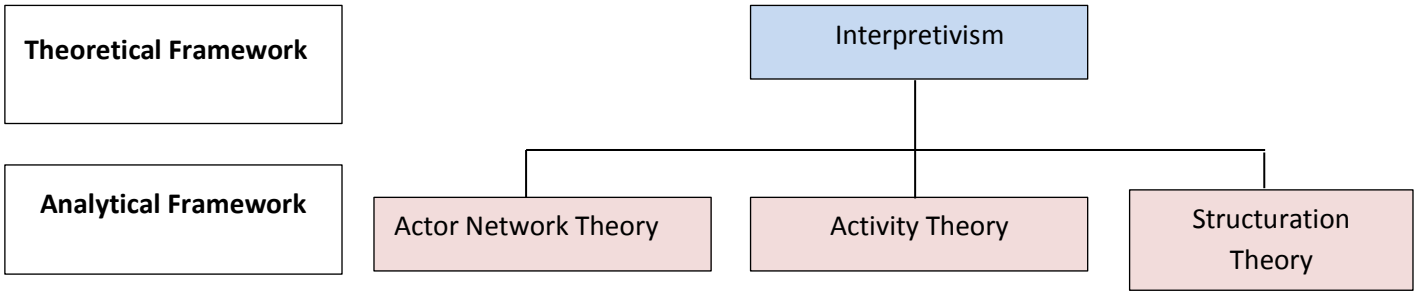


Figure 7: Overview of analytical framework options within an interpretive paradigm

4.2.2.1. Activity Theory (AT)

Activity theory (AT) originates from Vygotsky's concept of mediated action, where human action is more than a function of an internal biological process, but also mediated by culture and artefacts, including signs and tools. Human activity is also socially mediated (Leont'ev, 1978; Miettinen, 1999). An activity is a factor that ties individual actions to the context and these actions derive their meaning from the context. As a result, actions without context are meaningless (Mursu, Luukkonen, Toivanen, & Korpela, 2007). Such a perspective views human ICT interaction as an activity system consisting of various parts joined together by interactive activities of actors. This activity is channeled by mediators (Mlitwa & Van Belle, 2010). The final goal is the achievement of a specific and common objective, which in my research is a desired level of digital competence. The concept of an activity system or communities of practice is a series of containers, between which people, objects, practices and meanings move (Fenwick & Edwards, 2010). It is linear and two dimensional.

While this is a feasible approach to adopt, it was not the most appropriate for my research because activity theory represents human actions that are mediated by neutral or boundary artefacts. I argue that the phenomena impacting on the activity of coming to be digitally competent are not neutral, nor do they sit at the edge of pre-existing communities. The premise in activity theory, is that boundary objects work at the edges of Wenger's communities of practice, mediating their external relationships, "they enable co-ordination, but they can do so without actually creating a bridge between the perspectives and the meanings of various communities" (Wenger, 1998, p. 107). However in ANT, these

boundary objects do not sit on the periphery of a network, they can sit anywhere within a network. In ANT- related work, boundary objects are:

> …plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and maintenance of boundary objects is a key process in developing and maintaining coherence across intersecting social worlds (Star & Griesemer, 1989, p. 393).

The simple recognition in activity theory that things are ubiquitous in educational practices does not go far enough. In the quote above, ANT proponents emphasise that **things** are integral to such processes. Things exert force themselves. These things do not just respond to human intention and force. In fact, things change and shape human intentions, meanings, relationships, routines, memories, even perceptions of self (Fenwick & Edwards, 2010). My research looked at a student's attitude when working with digital devices, as well as their belief in their own ability. One of my interview questions asked the 28 phase two students how they felt when working with ICT devices. Interestingly, the majority of these students rated their experience as positive. Miller explains that in everyday life, material things can possess us as much as we possess them. 'Things' can compel memories and associations that we may or may not wish to make (Miller, 2005), For example, a student who has had previous negative experiences with ICTs may develop technophobia, or a fear of digital devices, and as a result be unwilling or nervous to engage with such devices in the future. They may have developed a low belief in their own digital ability (DSE) as a result. Pursuing a belief that things matter, that is, factors impacting on an individual's engagement with ICTs matter, activity theory was not a viable approach to adopt in my research.

4.2.2.2. Structuration Theory

The structuration theory of Tony Giddens (Giddens, 1984b) is a general theory of social organisation. It is a theory that seeks to understand what sort of things are out there in the world, but not what is happening to or between them (Craib, 1992). The focus is on social practices that jointly constitute both individual and society activities. As a result structure is said to be activity-dependent. Giddens identifies the "double hermeneutic" principle as the joint involvement of society and individuals. Practices are produced and reproduced across time and space. He advocates that structure consists of norms or rules and that the powers of signification, domination and legitimation are how humans or social agents make sense of

these rules or norms through interaction. Compliance with expected behaviour is not voluntary. It is legitimised, motivated and unacceptable behaviour is sanctioned (Mlitwa & Van Belle, 2010).

Jones and Karsten critique structuration theory as offering an insightful approach to analysing social phenomena but only at a high-level of abstraction (Jones & Karsten, 2008). As a result it was not suitable for direct application to the specific contexts I required for the purposes of my research. I did not adopt this approach as it became problematic when structuration theory attempted to rule out individual voluntary action. I argue that the individual students in my research did act to some extent in a voluntary manner in their process of coming to be digitally competent.

4.2.2.3. Actor Network Theory (ANT)

Actor network theory stems from the sociology of science. Michel Callon, Bruno Latour and John Law were the first writers to use the term ANT to describe their particular approach to scientific and technical innovation. According to them, society consists of networks of any material entity, human or nonhuman. The agency, or capacity to act, of actors constitutes the network, rather than mere connections of human and non-human actors (Ellis, 2013). Both human and non-human elements are considered equally as actors within a network. In other words, the same analytical and descriptive framework should be employed when faced with either a human, a text or a machine (Cressman, 2009). Latour clarifies this further in his book, *Aramis, or the Love of Technology*, when he states that "an actor in ANT is a semiotic (study of meaning making) definition – an actant – that is something that acts or to which activity is granted by another … an actant can literally be anything provided it is granted to be the source of action" (Latour, 1996, p. 373).

The few educational studies drawing from ANT work with it in highly diverse ways, often bending and twisting ANT ideas to better approach the question at hand (Fenwick & Edwards, 2010). ANT's key contribution is the suggestion that analytic methods should honour the mess, disorder and ambivalences that order phenomena, including education. As Law warned, the worst thing we could do is to re-establish and impose a purity of ANT-ness as: "only dead theories and dead practices celebrate their identity" (Law, 1999, p. 10). ANT cannot be described as a single, stable or identifiable framework. Rather, it is a disparate "set of tools, sensibilities and methods that treat everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located. It

assumes nothing has reality or form outside the enactment of those relations" (Law, 2007, p. 595).

Gourlay and Oliver, used ANT as an analytical framework in a large United Kingdom postgraduate institution specialising in educational research. They stated that mainstream accounts of digital competence create an impression of learners as "free-floating", romanticised agents, unencumbered by material concerns. Gourlay and Oliver argued that things must be contextualised and a successful study, such as mine, on coming to be digitally competent, involves the creation and co-ordination of socio-material assemblages that span material and digital alike (Gourlay & Oliver, 2014). Life, in education as well as other spheres, is never only about the personal and the social. It is about the socio-material (Fenwick & Edwards, 2010). ANT focuses on the minute negotiations that go on at the points of association. Things, not just humans, but the parts that make up humans and non-humans come together to connect with other things. The barriers students identify, even psychological ones such as one's computer attitude or belief in one's own ability, come together to connect with other factors in the development of an individual's digital competence. An ANT analysis traces these negotiations and their effects, and in the process shows how the things that we commonly work with in educational research are actually assemblies of numerous things. These assemblies order objects and actions, flows of movement and choices in space and time. ANT analyses can show how such assemblages can be unmade as well as made. It can also show how such networks can never be complete or totalizing. There are always gaps, holes and tears, and multiple networks vying to be effective (Fenwick & Edwards, 2010).

Can ANT be used in an educational setting such as developing digital competence? Fenwick and Edwards state that with regard to ANT in education, it can be used to clearly explain how artefacts may relate to each other to form a network of a particular learning environment in educational settings as follows: everyday things and parts of things – animals, memories, intentions, technologies, bacteria, furniture, chemicals, plants, and so on, are assumed to be capable of exerting force and joining together, changing and being changed by each other (Fenwick & Edwards, 2010). From their remarks and in Latour's 1996 study of the interactions of the stakeholders of a failed transport project, non-human actors that have no physical bodies, for example, technologies, memories and intentions can also be included as actors. ANT perceives that non-humans also have agencies to potentially alter human

actions. This is referred to as *translation* (Callon, 1986; Latour, 1991, 1996; Law, 1991b). It follows that non-humans in learning environments may have the tendency to shape learner's behaviours in certain ways and how they learn (Ellis, 2013). In my research, these non-human actors were computer attitude and digital self-efficacy.

Firstly I address the criticisms levelled against implementing an ANT research approach. These criticisms include the absurdity of assigning agency to non-human actors. Some even suggest that ANT is amoral. There is criticism that it assumes all actors are equal within the network and an accommodations for power imbalances can be made and finally that ANT leads to useless descriptions that seem pointless ("Actor-Network Theory (ANT).", 2016).

One of the criticisms is that agency is assigned to non-human actors. However, ANT is a research method that focuses on the connections between both human and non-human entities. It describes how these connections lead to the creation of new entities that do not necessarily practise the characteristics of other entities. This can be compared to what happens if a chemist puts together two chemicals. Connections between humans and non-humans can be traced. Only traceable connections from the empirical data should be part of the description that is made by the ANT researcher. This description reveals the connections that lead to the creation of a certain entity. ANT focuses on how the connections were established. Tracing back connections can be done by (participatory) observation, document analysis or in-depth interviews (Dzakiria, 2006). The fact that ANT does not make an analytical distinction between humans and non-humans is sometimes regarded as flawed. However, the differences between humans and nonhumans are not neglected, but have no a-priori relevance for ANT driven studies. A distinction is made between objects and things. ANT does see stable objects, such as chairs or computers as things that are the temporary result of a set of connections. As long as these connections hold, the object has the same essence. It is not changed by others, and it does not change others either. Its consideration of the agency of non-human actors, while controversial, remains relevant to fully understanding network processes and interactions (Whittle & Spicer, 2008).

ANT has also been criticised as an approach that only describes networks and does not explain why or how they were created. Latour points out that it is not a theory of anything, rather a method to implement, and explanation does not necessarily have to follow from description. It thoroughly explores the relational ties within a network (which can be a multitude of different things) (Latour, 2005). Bijker and colleagues responded to this

criticism by stating that the amorality of ANT was not a necessity because moral and political positions were only possible after one had first described the network (Bijker, Hughes, & Pinch, 1987). Whittle and Spicer note that ANT seeks to move beyond deterministic models that trace organisational phenomena back to powerful individuals, social structures or technological effects. Rather, ANT prefers to seek out complex patterns of causality rooted in connections between actors (Whittle & Spicer, 2008). By deconstructing groups in order to see what is going on inside of them, it is clear that every single entity is in fact a group of other entities. For ANT, the point is that groups are not stable. They are, or at least can be, remade over and over again. However, if *you stop making and remaking groups, you stop having groups*. All kinds of groups need to be remade every single day in order to keep alive. When the employees do not go to work anymore, the department does not exist anymore. ANT driven research wants to show the dynamics of the making and remaking of groups. Therefore every time again we have to wonder how groups have been formed by the actors involved (Dzakiria, 2006).

A third criticism of ANT is that it does not account for pre-existing social structures, such as power, race, class and gender, but rather sees these structures as emerging from the actions of actors within the network and their ability to align in pursuit of their interests. By asking the simple question of where does teaching and learning take place? One realises how successfully this practice has become black-boxed, to the point where it is simply taken for granted that (most) teaching and learning takes place in educational institutions. When considering issues of teaching and learning, there is often a tendency to focus on the specific sites of practices, for example schools and classrooms, so that all else becomes the context within which those practices take place. There is, then, a tendency to explore these external contextual factors as influences on what goes on inside the context. However, where and how we cut the network and what we take to be included within a specific context for elaboration, and whether we should cut the network at all, has both assumptions and effects (Fenwick & Edwards, 2010).

Critics have also argued that research based on ANT perspectives remains entirely descriptive and fails to provide explanations for social processes. However, like all other social scientific methods, a judgement call must be made by the researcher as to which actors are important within a network and which are not, or descriptions may become endless chains of association (Schultz, 2012).

Regardless, I contend that ANT contains within it concepts that, when abstracted from the multiple trajectories of ANT, can be used as tools to better reveal the complexities of our sociotechnical world. It is a valuable tool within the social study of technology (Cressman, 2009). ANT offers the potential for re-thinking taken for granted ideas that are problematised through such a radical approach. However, ANT cannot be reduced, once and for all, to a catch-all theory that can be universally applied. In other words, one person's use, or reading, of ANT may differ considerably from another's (Cressman, 2009).

4.3. Understanding ANT in the context of my research

What I found appealing is that ANT offered an unfamiliar take on many familiar issues. A priori (previously established) assumptions were avoided. Distinctions between the social and natural, between material and cultural, human and non-human, and between technical and social, were taken to be effects rather than foundational assumptions. They were seen to be network effects. Subjects, objects, agency and actions emerged from particular networks through which they co-emerge (Fenwick & Edwards, 2010). The *knowing* that I wanted to investigate was how students came to be digitally competent. There were factors or actors that impacted on this development. ANT analyses show how knowledge is generated through the process and effects of these assemblages coming together. Learning is not seen as simply an individual or cognitive process. Nor is it simply a social achievement. Learning itself becomes enacted as a network effect. Such an approach does all this by drawing attention not only to the importance of things, to the non-human things, but also to the intimate associations between objects and all human attributes, capacities and activities (Fenwick & Edwards, 2010).

I used ANT to explore the factors that impacted on the development of digital competence and show how things were invited or excluded, how some linkages worked and others did not. Associations are bolstered to make themselves stable and durable by linking to other networks and things. Using an ANT analysis it is possible to focus on the minute negotiations that go on at the points of association. *Things,* not just humans, but the parts that make up humans, and in my research: specifically attitude and digital self-efficacy, and non-humans – persuade, resist and compromise each other as they come together. They connect with other things in ways that lock them into a particular association. ANT followers believe that we are in a world of precarious correlations rather than cause and effect (Fenwick & Edwards, 2010). Returning to my previous assumptions; if you have a positive computer

attitude, you will become digitally competent. If you have a strong belief in your own ability, you will learn how to use ICTs. If you are young, it is easier for you to use ICTs effectively. There are many cause and effect scenarios that I can mention from my research. Assumptions I presumed were to some extent stable and true at the onset of my research. As I delved deeper into the factors that impacted on a student's coming to be digitally competent, factors that acted as either enablers or barriers, I became more aware that these hypotheses did not necessarily hold true for each student. I show in chapter eight that each student's learning network is unique.

4.3.1. Factors or actors in ANT

It was easy to identify barriers that students face when interacting with ICTs and learning how to use them. The students in my research identified these for me when completing the online questionnaire. More difficult was establishing whether these factors impacted on the learning experience, and even messier was trying to explain how multiple factors or phenomena impacted on each other in the network effect or experience of coming to be digitally competent. My objective was to understand how human and non-human actors came together and managed to hold together, however temporarily, to form associations that produced agency and other effects. Agency and other effects could be ideas, identities, routines and instruments. In educational discourse, such an approach leads to questioning of common categories and distinctions, such as teacher and learner, curriculum and pedagogy, formal and informal learning, and in my research, barriers and learning networks (Fenwick & Edwards, 2010).

An actor is an association between entities which is not recognisable as being social in the ordinary manner *except* during the brief moment when they are reshuffled together. An actor is allowed to be heard and tell their story rather than caging them in. There is an interest in the ways that human and non-human elements have become woven into objects. An actor does not have to be a physical thing. It can be an association between things. Connections and translations bring objects to presence. ANT researchers track the movements and politics of these objects as they create everyday practices in particular ways (Fenwick & Edwards, 2010). To successfully understand the network, focus on actors and their relations and associations is necessary. Actors can encompass, represent and shape the make-up of all other actors involved in the network. Actors can also translate other actors' interests to that of their own (Callon, 1991). Actors have the power to change other actors. Originally,

Latour (1987) referred to human actors as actors and non-human actors as actants. Actants could act as actors and networks simultaneously. It is a term that is used to stress that material causes as well as human actors may result in social interactions. By using the word actant, the focus is shifted towards the actions of an entity rather than the actual entity or actor. The word network then focuses on the outcomes of these actions. When two or more actants are connected, they form a network. Dankert explains that if one zooms out until the connections between the actants in the network cannot be seen, then the actant-network appears as one actant. If one then zoomed in on any actant, the connections between the actants would become visible again (Dankert, 2011). However, there is no difference between the value of actors and actants and the terms are used interchangeably in recent ANT literature (Harrt, 2013). In later work, Latour refers to the actors, actants, intermediaries and mediators within networks as nodes (Latour, 2005). Actors and, or actants represent a node within a network connecting to, impacting on, resulting in another node within the network. Node is a concept taken from social network theory. Social network theory maps all the relevant ties between nodes being studied to determine the social capital of individual actors. Nodes are the individual actors within networks and ties are the relationships between the actors (Wade, 2014). Barab, Hay and Yamagata-Lynch also use the term **node** to represent both actors and actants in networks in their research to capture the process of learning (Barab, Hay, & Yamagata-Lynch, 2001). When presenting the students' networks of learning in chapter 8, I also use the encompassing term, node, to refer to actor and actant points in the network.

ANT offers a critical perspective to understanding the technical and the social aspects of techno-social interactions (Latour, 1987, 1991). It opposes any position that seeks to view an actor within a network **independently** of every other actor or phenomena in the network. It suggests the elimination of all *a priori* distinctions between the technical and the social (Mlitwa & Van Belle, 2010). Investigating the development of digital competence from an ANT perspective requires the recognition of a negotiating interplay between the human and the technological devices. Through such a lens, it is not possible to view technology as just a neutral passive object, but rather as an actor on the same analytical level as humans (Mlitwa & Van Belle, 2010). Unlike the implications of activity theory where the activity system represents human actions that are mediated by neutral artefacts, ANT presents a network as a sum of inter-related and causal connectedness of all factors on any social-technical account (Mlitwa & Van Belle, 2010). The significance of a network is in its continually negotiated

processes where both human and non-human actors have a mutual and causal influence in network processes (Toumi, 2001).

While it may be confusing to contemplate how something can be both an actor and a network, in ANT, everything can be considered as both an actor and a network. "An actor-network is simultaneously an actor whose activity is networking heterogeneous elements and a network that is able to redefine and transform what it is made of" (Callon, 1986, p. 93). As the social is not stagnant but always changing, ANT seeks to discover new actors and make connections through controversies rather than trying to solve them. In order to do this the researcher has to let go of all preconceived notions.

A problem arises in the assumption of a supposed claim of symmetrical power that the technical and human actors exert a similar level of influence on each other. It is argued whether the technical and social actors need to then have similar "cognitive capabilities" in order to occupy symmetrical roles of influence in a socio-technical network (Mlitwa & Van Belle, 2010). I viewed the first year pre-service teaching ICT course as a socio-technical network that incorporated digital devices such as computers and phones, applications, learning material, students, attitudes, efficacies, lecturers and peers. There was a level (albeit not a symmetrical one) of influence between all the technical and social actors here. However, tools are seen as incapable of engaging in cognitive decision processes and are understood to have a significant but lesser level of influence in the socio-technical network (Mlitwa & Van Belle, 2010). For example, humans may choose to ignore technical artefacts if they have negative perceptions of its usefulness or find it complex or user-unfriendly. The complexity of digital devices was mentioned by a student who said ICTs were *"too complicating and sometimes tedious"* (18 year old female first year student). Students also had problems with both the complexity of the hardware as well as the inaccessibility of the software – *"a laptop is very complicated, especially Windows 8"* (18 year old female first year student). These were just two examples in my research of students who had a negative perception of a device's usefulness. The complexity of the device and its user-unfriendliness was listed as a barrier to their effective access of digital devices.

An example used to clarify the explanation of actors in ANT is an item on the supermarket shelf. What networks are in effect to result in this item, for example, a box of cereal ending up on the supermarket shelf? I further explore this network example. Each node or small dot in the image provided in figure 8 below forms part of a larger network. A network of farmer,

field, irrigation, seed, weather and soil conditions result in the cereal being grown. A network of farm workers, harvesting equipment, irrigation, suitable weather conditions, and transport to the mill house result in the cereal being harvested. Another network comes into play when the cereal is washed, ground, packaged and distributed to the packaging house. Here it is flavoured, packaged in a box which was produced by another network entirely. Such a network involves trees grown and felled to produce the cardboard that the cereal box is made of and the plastic inner that the cereal is stored in. At the packaging house, the cereal is weighed by a person using a scale that had been made from plastic and calibrated in yet another factory or network. Yet another network produces the final printed box which involved designers, ink, printing machines. The final product is transported to the distribution warehouse where it is unpacked and then packed onto a truck that was designed by another network of actors and built by yet another network and driven to the shop where it is placed on the shelf. A network is involved in deciding on the price, barcoding and programming the barcode and relevant price at the till. An individual needed to be trained to use the barcoding and programming software and device accurately. A lady with two small children drives to the shop and picks up the box, puts it in her trolley and takes it to the till where a cashier rings up her purchase. The shopper pays for her purchase using a credit card which involves another network involved in the production of this plastic card as well as the networking connections back to her banking institution. She then got in her car and drives home and pours the cereal in a bowl for her children. She adds milk and gives each of them a spoon. The number of networks is endless and complex. Some overlap, some only exist in the instance that they are needed and then they dissolve. I am aware that I have missed many actors within each network, but I have demonstrated the complexity of each network and how human and non-human actors come together to form a network. Multiple networks come into play in any one instance, *assemblages*, in this example, a cereal box on a supermarket shelf.

The diagram below, which appears on the cover of (Fenwick & Edwards, 2010)'s book, best illustrates how each network is made up of various nodes and actors. These interact, overlap, and resist each other.

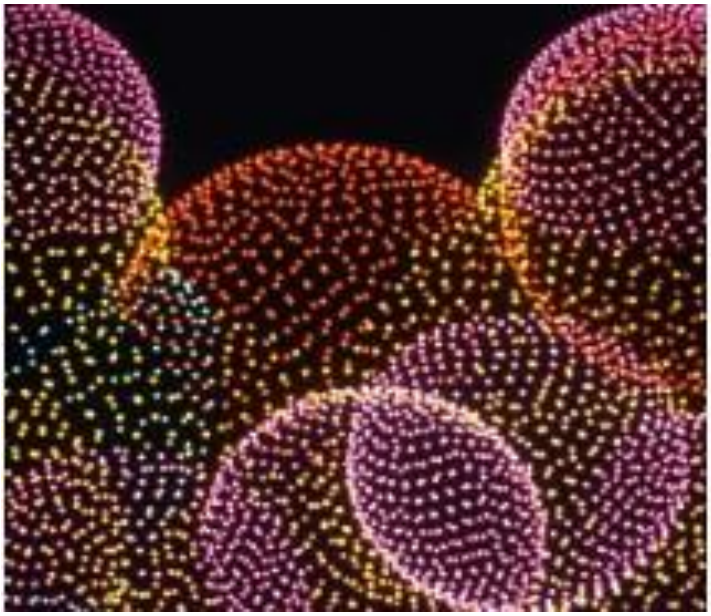


Figure 8: Diagram presenting a network as a sum of inter-related and causal connectedness of factors / agents (Cover of Fenwick and Edwards, 2010, book – Actor-Network Theory in Education)

It was interesting to note in my research findings that some of the barriers first year pre-service teaching students encountered were human and some non-human. The student had little control over these. Computer attitude as well as digital self-efficacy may be an actor or actant acting on the process of the students in my research coming to be digitally competent in their unique learning network. Most ANT studies trace all things as enactments that are *effects* continually produced in webs of relations (Fenwick & Edwards, 2010, p. introduction). Like ANT studies I was interested in the ways human and non-human elements become interwoven in webs of learning.

4.3.2. Punctualisation and depunctualisation in ANT

Digital competence is an achievement that involves the successful coordination of human and non-human actors – including for example, teachers, other learners, digital devices and texts. In my research, I used ANT to analyse and interpret the growth and structure of knowledge through the interactions of actors and networks. It is a way of explaining the relational ties within a network without worrying about explaining ***why*** or ***how*** a network takes the form that it does. Clusters of actors involved in creating meaning come together to act as a whole (Gourlay & Oliver, 2014). When these clusters act together and a network is functioning well, ANT proponents say that *punctualisation* is occurring. Returning to the cereal box example, the farming of the cereal is functioning perfectly. The weather and soil conditions are perfect. Irrigation and fertilisation of the growing plants has been ideal. Punctualisation

is the process by which a number of networks are substituted by a single element or actor with which other agents interact. Just within this growing process alone there are numerous networks in play. For example, the irrigation network - there needs to be water supply to the farm. This water supply may come from a dam which is dependent on rainfall or supply from another source. The water needs to make its way to the farm through a series of pipes and pumps. It then needs to be distributed across the crops through an irrigation machine. Each nozzle needs to be clear and provide an uninterrupted source of water. A timer or human being is required to operate this irrigation machine and ensure that the correct amount of water is sprayed on the crops. Too much will result in overwatering and destruction of the crops, too little will result in them drying out and not growing. Plants need sun and favourable weather conditions to grow. Just the irrigation network is made up of other networks. Who made the irrigation machine? Where did the metal come from? Who designed it? Where did the farmer buy it from? How did it get to the farm? Who built it on the farm? Who was taught how to operate it? How were they taught? Who did they teach?

I use this analogy again to illustrate that when each of these networks functions perfectly, *punctualisation* has occurred. When an established network functions well and is essential to the network of the cereal box ending up on the supermarket shelf, it can be 'black-boxed'. The entire irrigation network can be black boxed and the actors within it closed to the human eye and mind. You stop worrying about the irrigation process. It happens successfully and is taken for granted. If something goes wrong within the irrigation network, *depunctualisation* is said to occur. Now the black box must be opened and all the elements inside made visible and examined. If the plants stop growing, there may be something wrong with the irrigation process. This network is now examined and it may be found that there is a problem with the water supply. It may have become polluted. The quality of water supplied to the farm may have been compromised. The network of water supply to the dam needs to be investigated and resolved. This network of irrigation has an impact on all the other networks that work together in the end result of the cereal box ending up on the supermarket shelf.

4.3.3. Nodes and networks

The identification or chunking of raw data into meaningful units or nodes is the first step in the creation of a network. Barab, Hay and Yamagata-Lynch refer to these chunks of meaning as AREs, which is an acronym for action-relevant episodes, with an emphasis on activity and participation (Barab, et al., 2001). AREs are identified as activity occurrences that are judged

to be a significant happening in the context. What qualifies as a significant happening or a segment is somewhat subjective and specific to the needs and interests of each particular research context. Lincoln and Guba (1985) described two criteria for selecting units of analysis. Firstly they must be heuristic, or solvable, and secondly they must be the smallest piece of information about something that can stand by itself. This is dependent on the subjective needs and interests of the researcher.

Barab et al. conducted a study that analysed actor networks in project-based astronomy courses at two universities by identifying links between the issue at hand and an initiator of each activity. He and his team of researchers found that through they could trace the emergence, evolution and diffusion of students' understanding and visualisation of eclipses. They focused on the interaction between the agent and the environment and what constituted the particular experiences that led to the understanding of eclipses (Barab, et al., 2001). ANT has also been used in previous research to investigate, contextualise and analyse socio-technical applications of ICT (Trusler & Van Belle, 2005). In previous educational studies ANT was used in a Japanese private university involving 1800 second year Science and Engineering students. It was a study that used ANT as a lens to investigate learner behaviour and learning environments in a foreign language classroom. ANT was used to trace student interactions between humans and non-humans with reported findings suggesting that many non-human factors influenced the in-class activities (Ellis, 2013).

I analysed actor networks in a practical ICT competence course at the HEI by identifying links between the **issue at hand**, namely the factors that impacted on the process of coming to be digitally competent, and the **initiators** of this activity. These were the first year pre-service teaching students. While Barab and his researchers only studied observable initiators or actors, I have included non-observable initiators and actors. I will discuss this in further detail after I have presented Barab's framework of AREs.

Barab and colleagues constructed networks of action-relevant episodes (AREs) to identify relevant data from a complex evolving environment, and then to organise it into a web of action that can illuminate the historical development (evolving trajectory) of the phenomenon of interest. In my research, this phenomenon of interest is the process of the students coming to be digitally competent. To accomplish this, experiences are firstly sectioned into action-relevant episodes (AREs), secondly assigned to codes in a database, and thirdly represented as nodes in a network so that the historical development of the particular phenomenon of

interest can be traced. Barab and colleague's research focuses more on observable behaviours, whereas the emphasis in my research differs as I also identified non-observable behaviours or factors impacting on the student's process of coming to be digitally competent. These included the students' perceptions of barriers and enablers that they felt negatively or positively impacted on the development of their digital competence in their first year of study at the HEI.

The summary labels for the various features that constitute a node according to Barab et al., 2001, are indicated in table 12 below. The categories, as detailed by Barab et al. are in the first column. A description of each of these categories as indicated by Barab et al. is provided in the second column. In the third column I discuss the appropriateness of applying these categories to my research and expand on the initial descriptions in order to extend them to my research. A discussion on the effectiveness and possibility of applying this framework or parts thereof to my research is presented after table 12.

Table 12: Summary labels for various features that constitute a node in actor network theory

Category	Barab's description	Description as used in my study
Issue at hand	A summary label that is chosen to identify the content of the node. It is the "direct" object of discussion or manipulation (the only way a practice can be considered an issue at hand is if it becomes the explicit object of discussion or manipulation). It can refer to an artefact, tool-related practice, or conceptual tool or process.	In the process of coming to be digitally competent I identified factors that impacted either negatively or positively on this process. The issue at hand was one of these factors, e.g., access to ICTs, age, previous experience.
Initiator	An individual or group (when engaged in a practice as a single unit) that is producing an action. Although we listed only observable initiators, it is important to note that actors do not emerge in a vacuum; rather, they exist within a context that is reciprocally constituted by the cultural surround and transformed by their initiator actions. In this fashion, the cultural surround could arguably be considered an initiator involved in defining the specifics of the issue at hand. However, it becomes impossible and overly presumptuous to define the numerous aspects of cultural influence that interact with the issue at hand. Therefore, we have not included non-observable (yet potentially important factors) in our coding scheme and must acknowledge this as a limitation. We have also not included nonhuman objects, such as computers; instead, the contribution of these objects to the historical development of a particular tracer is captured as part of the network as a resource	The HEI required students to pass an ICT competence course and the students themselves wanted to become digitally competent with 83% indicating that they wanted to improve their digital competence skills. The initiators in my research were both the HEI and the students themselves. In the interviews I asked the students if they feel that they were forced by anyone to improve their digital competence skills. The majority replied that they had experienced this. Seven students felt having to type assignments at the HEI forced them to improve their skills. Others made note of parents, peers and the ubiquitous nature of ICTs as a compelling force. Unlike Barab et al., I identified both observable and non-observable factors. The feelings that the students themselves expressing – *I want to improve* is a non-observable initiator. Another difference to Barab et al.'s study is that I also included nonhuman objects, such as the technology itself as numerous students commented that they needed to improve their digital competence skills due to the ubiquitous and ever-advancing or developing nature of the technology itself.
Participant	An individual who is involved in a node but not initiating the action.	The first year pre-service teaching students are the initiators in the nodes that make up the web of action of coming to be digitally competent. Barab et al. detail these participants as not initiating the action. Participants in my research would be the students' peers as well as course presenters and teachers.
Resource	"Any piece of information, object, tool, or machine" that the initiator uses to carry out a practice (Roth, 1996, p191). In addition to technological tools, our definition of tool includes those of a social nature (e.g. community norms). An artefact is transformed to a resource when it is used by an actor as part of a practice. As such, it is important to note that it only becomes a resource within a particular node if it is being used by an initiator to support a practice.	The students in my research listed many resources that assist them in the web of action of coming to be digitally competent. These include course manuals, peers, the digital device itself, the Internet and software.
Practice	An activity that is carried out by an initiator who is using a resource. Practices can be tool related (i.e. embodied tool-related laboratory skills), scientific (i.e. calculating), instructional related (i.e. coaching), leaning related (i.e. using an inquiry strategy), or conceptual (theorising about quantum mechanics) and always involve the use of a resource.	The resource was the digital device, and other resources mentioned above, that the participant, the first year student, used to help them develop a certain degree of digital competence. The practice itself was this interaction with the student and the resources in the activity of coming to be digitally competent.

The web of activity of coming to be digitally competent is made up of various nodes or actors. The connections between the nodes can be permanent or exist only for the moment they are needed. Each node itself is made up of an issue at hand, initiator, participant, resource and practice.

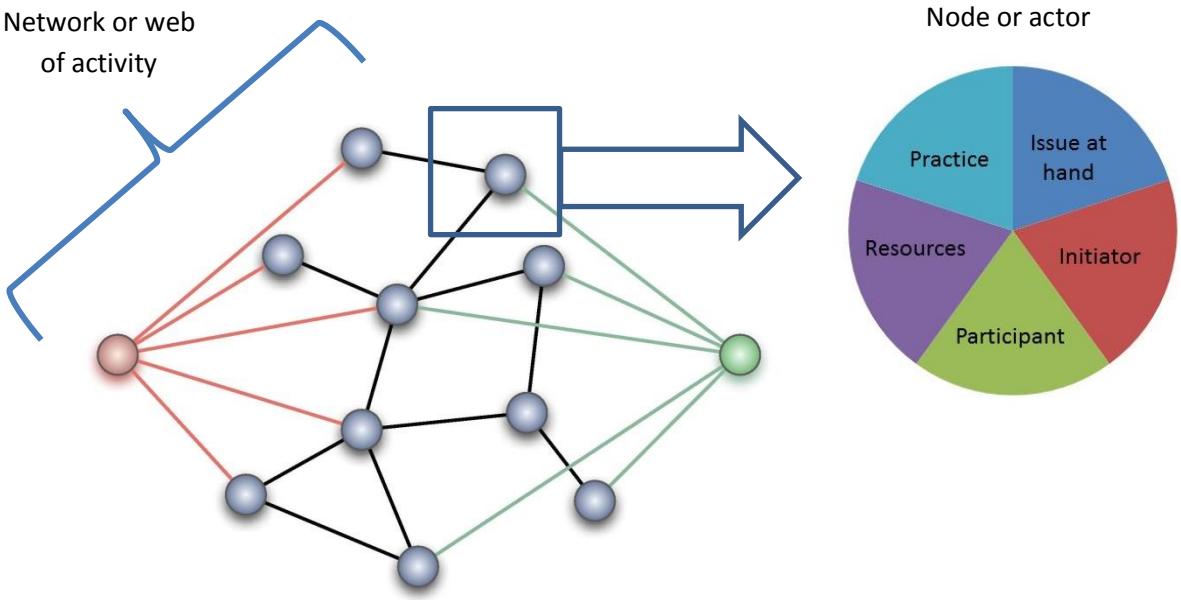


Figure 9: Nodes or actors interacting, connecting and impacting of the web of action of coming to be digitally competent

Figure 9 above illustrates a network or web of activity. Each circle represents a node or actor within that network. The image to the top right illustrates the structure of each node or actor by examining what the issue at hand is, the initiator, participant, resource and practice. The world is a continuously generated effect of the webs and relations within which they are located (Law, 2007). Unlike Barab, et al., I did not examine specific episodes and I did not observe the students in their actual learning situation. My research focused on the various nodes that worked together and formed a web of activity or network in the process of the student coming to be digitally competent. I identified the nodes or actors and then set about describing a network or web of action as to how these nodes worked together in the process of coming to be digitally competent. I also proposed that the nodes or actors may either be negative or positively charged as they interacted in the complex web of action of coming to be digitally competent. Each node hampered or enabled the learning process. However, a

negatively charged node may also have inspired a student to overcome a negative or difficult experience and they learnt and grew from it in the process.

The **issue at hand** is a label used by Barab et al. to describe the content of the node. It is the explicit object of discussion or manipulation. It can refer to an artefact, tool-related practice, or conceptual tool or process. Latour (1996) describes a node as an actant; something that acts or to which activity is granted by another. He details an actant as being anything provided it is granted to be the source of action. The enabler or barrier that the student identified as impacting negatively or positively on the process of them coming to be digitally competent was an actant or actor. The issue at hand in each node or actor in the web of activity of coming to be digitally competent was a barrier or enabler as identified by the initiator or student. The issue at hand, initiator, participant, resource and practice existed together in a brief moment to form an actor or node.

An **initiator** is an individual, namely the participant, or student who is producing an action. Barab et al., also suggest that activities do not emerge in a vacuum and that they exist within a context that is reciprocally constituted by the cultural surround. This cultural influence could be argued to be an initiator involved in defining the specifics of the issue at hand or even which practices emerge (Barab et al. 2001).

Barab et al., present **participants** in their third category of what constitutes a node as the other individuals who are involved in the network but do not initiate the action. Participants in my research were the students' peers and included the course presenters and teachers. Eight percent of the students responded that a digitally competent other would help them develop their own digital competence. Further findings revealed that 17% of the students indicated that a lecturer or tutor would assist them, 15% mentioned their friends and 15% indicated their family helping them.

Resources are the tools that allow the participants to develop and learn. Barab et al. found it useful to distinguish between the tools that students use (resources) from the tools that support the act of using these resources – referred to as practices. A resource is any piece of information, object tool or machine that an initiator uses to carry out a practice (Roth 1996). This could be course notes, manuals, the help facility available on the Internet, or even the device itself. Prior experience with digital devices could also be a resource that the student draws upon.

Practice is an action carried out by an initiator or participant, for example, a specific act of a lecturer showing the student how to do something. Practice could also be a participant or peer helping a student (initiator) overcome a problem with ICTs that he or she is battling with. Practice might constitute the student working through the online course activities and material provided by the HEI.



Figure 10: Categories of a node or actor

There is more than one node at work in a web of activity and some may impact more on the process than others. The link between each node may exist permanently or only be present in that instance when the issue at hand comes to the fore. It would be advantageous at this point to look briefly at a specific node in a student's web of activity in their process of coming to be digitally competent.

To better explain this, I use figure 11 below to provide an example of a specific student, Samuel's node components. I provide more detailed figures illustrating other students' unique networks of learning and how the nodes relate to each other in chapter eight. Samuel completed the online questionnaire in phase one. He was the initiator of this node within his network of learning to be digitally competent. Samuel was an 18 year old male first year pre-service teaching student. He rated himself as a novice ICT user. The practice he was involved in was that of going to digital competence lectures at the HEI. The resources that he mentioned using were the course notes, his friends or peers and someone who already knew how to use a computer. The issue at hand or barrier that affected his network of learning to become digitally competent was his previous lack of experience with ICTs.

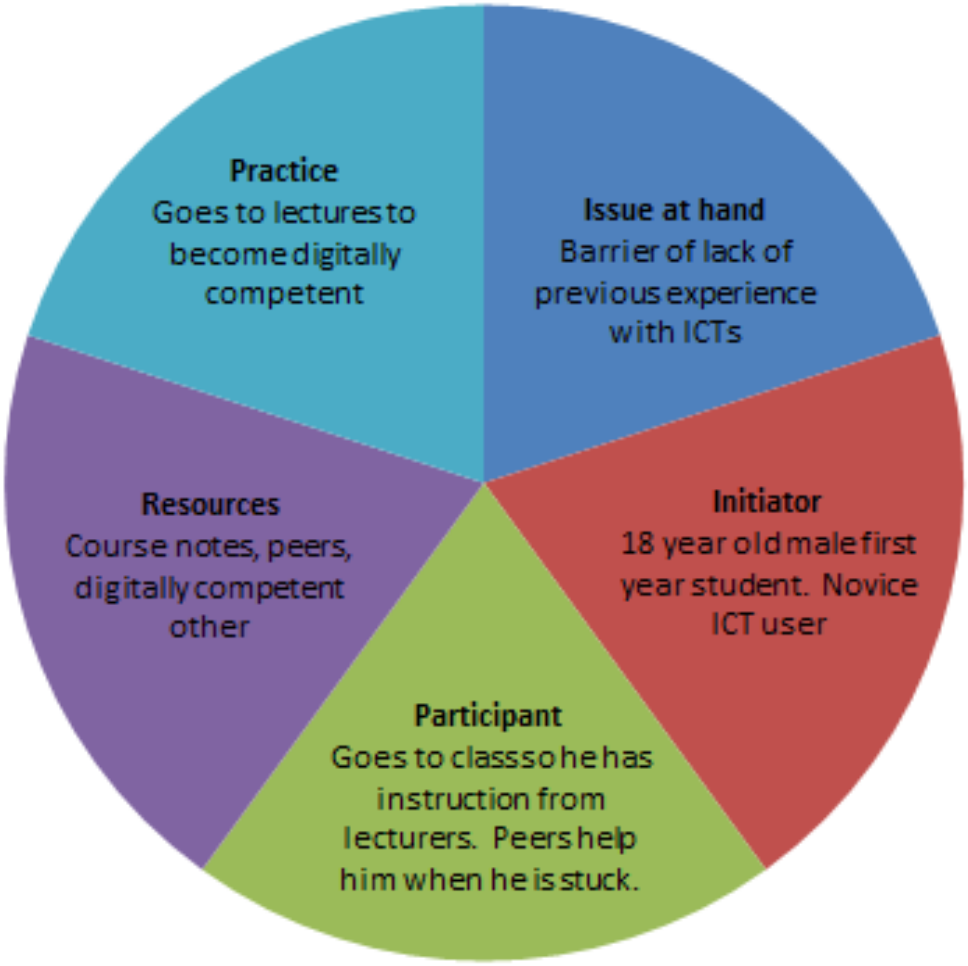


Figure 11: Categories of a node within a web of activity of Samuel coming to be digitally competent.

I use the above example to explain my interpretation of node categories and how they relate to the identified nodes in a student's network of learning. I use similar illustrations later in chapter eight, where I explore each node in a web or network of learning in six specific students.

4.4. Concluding remarks

The purpose of chapter four was to provide an overview of the theoretical underpinning and analytical reasoning I applied to my research findings presented in the chapters that follow. I used a practical analytical framework based on actor network theory (ANT) as a lens to investigate the development of digital competence of the first year pre-service teaching students at the HEI. I examined how students came to be digitally competent and the phenomena or factors that may have impacted on the realisation of this. A scientifically sound research approach – which is a "philosophical and theoretical framework that guides research" (Kekwaletswe, 2007, p. 95) was required. I did not use ANT to disclose the

educational issues in the first year ICT competence course. I already knew what these were; there were students who were passing and students who were failing the baseline digital competence test. Certain students were already digitally competent when they entered the HEI in their first year of study and yet there were others who were battling to develop a required degree of digital competence. Barriers and enablers that impacted on a student's engagement with ICTs were encountered. I applied ANT as a way of intervening in the above mentioned educational issues to reframe how first year course designers and presenters might enact and engage with them. ANT cannot and should not be reduced to a catch-all theory that is universally applied. One person's use, or reading, of ANT may differ considerably from others. ANT ideas are best utilised as an approach, a sensibility and a method for understanding, not a totalising theory of the world and its problems. It is a way of intervening in or interrupting education rather than simply a different way of representing education (Fenwick & Edwards, 2010). My research is an original application of ANT as an analytical framework in research that investigated the development of digital competence and the factors, phenomena or actors that may impact on this.

In the following chapter five, I establish a definition of digital literacy unique to the first year pre-service teaching students at the HEI. I also document their digital competence levels as they enter the HEI.

Chapter 5 - Digital Competence

I provided a literature definition of digital competence in chapter two. In this chapter, I establish to what extent the pre-service teaching students' perceptions of digital competence are congruent with that of the literature as well as their digital competence levels as they entered the HEI to commence their first year of study. My first two research questions are addressed in this chapter:

> ***Research question 1. What are the first year pre-service teaching students' perceptions of digital competence?***
>
> ***Research question 2. What are the first year pre-service teaching students' current levels of digital competence?***

The first question was answered using qualitative data obtained from the first year pre-service teaching students' completion of the online questionnaire and answers provided in interviews. I propose a definition of what the students perceive digital competence to be before presenting findings from the baseline test of two groups of first year pre-service teaching students' levels of digital competence when they enter the HEI in the years 2013 and 2014. The second question was answered using quantitative data collected from the baseline digital competence tests administered in 2013 and 2014.

5.1. Independence and digital competence

As mentioned above, a general definition was reached through an investigation of the history of computer literacy, information literacy, digital literacy and finally digital competence in chapter two. Digital competence is the essential knowledge needed to function **independently** with digital devices. It is both knowledge and skill - it is knowledge of procedures and the skill of being able to adapt and learn new procedures. Digitally competent individuals may consider the ability to self-teach, i.e. to learn arbitrary new programmes or tasks as they are encountered to be central to digital competence. It is a term that encompasses the set of knowledge, skills and attitudes including abilities, strategies, values and awareness that are required when using ICTs (Ferrari, 2012). In chapter two, a significant notion in the definitions was that of independence (Gee, Hull, & Lankshear, 1996; Hoffman & Blake, 2003; Stewart, 2011). Independence includes being able to self-teach and one of the questions I asked the 307 students who completed the online questionnaire was;

who was teaching them to become digitally literate? Twenty-one percent answered themselves, with comments such as: "*myself, through trial and error*" and "*I taught myself everything I know about computers by experiment and using the computers and cellphones* [mobile phones] *in my own time*."

Of the 21% of students detailed above who stated that they were relying on themselves to become digitally competent, 3% considered themselves to be novice ICT users, 33% beginner ICT users, 53% intermediate ICT users and 11% advanced ICT users. The majority of the students who completed the online questionnaire considered themselves to be either beginner or intermediate ICT users. More detail on the perceptions of the student's own self-rated ICT ability and their baseline test results is provided in table 26 in this chapter. Many of the responses about who would help the students become digitally competent were a combination of possibilities such as; "*my brother, myself and my lecturers will help me".* When coding and analysing the data, I split these responses up and allocated a response to each of the three categories: for example, family, myself and digital literacy tutor as is evident in table 13 below. For this reason, table 13 shows the actual responses (378) and not the number of respondents (307). Of the 307 students who completed the online questionnaire, just over half (55%) listed other people, such as, another person who was already digitally competent, a digital literacy tutor, friends or family, who they hoped will help them become digitally competent. A digital literacy tutor was a lecturer or any staff member at the HEI working in the computer laboratories and differed from a 'digitally competent other', in that they were remunerated to teach the students.

Exploring the possibility of other individuals mentioned above assisting the students, of the 378 responses, 57 students (15%) mentioned a friend in their response. A digital literacy tutor or lecturer, 17%, was also seen to be fundamental in helping an individual become digitally competent. One student said; "*a friend, but honestly I don't have anyone who's willing actually to do it for free*." Family members were relied on, and these accounted for 15% of the responses. Any other person who was more digitally competent was included in 8% of the responses.

Twelve percent of the respondents mentioned courses that were offered at the HEI helping them become more digitally competent. The HEI presented a First Year Experience (FYE) programme which was a bridging programme presented during orientation week to help bridge the gap between high school and university. A basic computer literacy course formed

part of the FYE programme. Five percent of the responses mentioned that this specific course was helping them become more digitally competent.

A few of the students (3%) used the Internet – both online courses and online help, to help them develop their digital competence skills. Hoffman and Blake reiterate this in their research when stating that students acquire their technology literacy in two ways: formally through the school programme or workplace, and informally, whether at home, from friends, or by themselves (Hoffman & Blake, 2003). The statistics discussed above are represented in table 13 below.

Table 13: Student responses to online questionnaire question: Who will teach you to become digitally literate?

Who will teach you to become digitally literate?		
Myself	78	21%
Digital literacy tutor	66	17%
Friends	57	15%
Family	56	15%
Courses - 18 (5%) students specifically mention FYE	47	12%
Another who is digitally competent	31	8%
I don't know	20	5%
The Internet	11	3%
No one	4	1%
I am already digitally competent	2	0.5%
Devices	1	0.5%
Manuals	1	0.5%
Society	1	0.5%
Blanks / unanswered	3	1%
TOTAL RESPONSES	**378**	

As mentioned previously in section 3.4.3., it was necessary to perform an inter-rater reliability test on the coding of this data. Inter-rater agreement is important to perform because it ensures internal consistency for reliability (McMillan & Schumacher, 2006). Two data raters, namely myself and a colleague independently rated the students' responses and agreed with the way the data had been rated to ensure consistency in measurement. The agreement is referred to as a correlation coefficient or percentage of agreement. Employing

Cohen's Kappa as a statistical measure, a confidence limit of 0.81 was achieved. This indicated a strong level of agreement between the two data raters.

Responses to the first question, which asked the students **who** was teaching them to become digitally competent, are detailed in table 13 above. A course and the Internet were not actual people, but 16% of the respondents revealed that in addition to an actual individual, the Internet or a course, manuals or the ICT devices themselves also assisted them. I included these responses in the analysis of the answers to the first question and shaded them red in table 13 above. The students either did not understand the question or no individual was helping them, rather they saw these non-human agents as assisting them become digitally competent.

The students' responses were complex and multi-facetted. Referring back to an analytical framework of actor network theory, it was evident that support in becoming digitally competent could not be reduced to just one agent. Many students operated within a network of agents that may advance or possibly even hinder their development of digital competence. The notion of students operating within a network is discussed in further detail in chapter six where I investigated the barriers and enablers that students experienced in their engagement with ICTs. Further exploration in this regard is made in chapter eight, where students provide accounts of how they came to be digitally competent.

Returning to the notion of independence and digital competence which is the thrust of this section in chapter five, it was interesting to note that the largest percentage of the students surveyed responded that they were relying on themselves to become digitally competent. Further analysis into possible links between self-teaching and independence with computer attitude and digital self-efficacy are explored in chapter seven.

5.2. Tools used in the development of digital competence

The second online questionnaire question asked the students **what** they were using to help themselves become digitally literate. Responses to the question are detailed in table 14 below. Many of the responses about what the students were using to help them become digitally competent were a combination of possibilities such as; "*I use manuals and programme books as well as advice from an IT programmer"*. When coding and analysing the data, I split these responses up and allocated a response to each of the two categories: for example, manuals and digital literate other as is evident in table 14 below. For this reason,

table 14 shows the actual responses (367) and not the number of respondents (307). Of the 367 responses in the online questionnaire, just over half (54%) indicated that the students were using a digital device such as a desktop computer, laptop or tablet device to help them become digitally competent. The other most notable tool students were using was their mobile phones, 17%. The remainder of the tools mentioned all scored below 5%, with the Internet being the highest at 5%. In this category, one student stated using YouTube, while others used the Internet to search for information on how to use a device.

Four percent of the respondents mentioned courses in helping them become more digitally competent such as online courses, typing courses or the first year computer competence course offered at the HEI. The First Year Experience (FYE) bridging programme presented during orientation week was mentioned by just 4 (1%) of the students. The statistics discussed above are represented in table 14 below.

What are you using to help yourself become digitally literate?		
Computer	197	54%
Mobile phone	63	17%
The Internet	20	5%
Experience, practise and experimentation	14	4%
Courses - 4 (1%) students specifically mention FYE	13	4%
Nothing	12	3%
Manuals	12	3%
Friends	8	2%
Digitally literate other	5	1%
Family	4	1%
Myself	3	1%
Social networks	1	1%
Blanks / unanswered	15	4%
TOTAL RESPONSES	**367**	

Table 14: Student responses to online questionnaire question: What are you using to help yourself become digitally literate?

I performed an inter-rater reliability test on the coding of the data in table 14. Employing Cohen's Kappa as a statistical measure, a confidence limit of 83.4% was achieved. This indicated a strong level of agreement between the two data raters.

I was initially surprised that so many (17%) of the students reported that a mobile phone was the tool they were using to help themselves become more digitally competent. Further investigation into my data revealed that 51% of the students owned their own desktop computer or laptop, yet a large number, 256 of the 307, (83%) students had a mobile phone that could access the Internet. In South Africa, mobile phones are more affordable than a laptop or desktop computer which could account for this high ownership statistic. In South Africa, mobile phone usage and ownership is prolific. Research into mobile phone penetration in South Africa conducted in 2014 indicates that 90% of South Africans own a mobile phone. Of these, 34% own a mobile phone that could access the Internet and 55% a regular mobile phone (PEW Research Centre, 2015).[11] Kavanaugh and colleagues conducted research into the use of mobile phones by low computer literacy populations to help them learn computing. They suggest that individuals with low computer literacy could use their experience with fixed line telephones to learn how to use a mobile phone, and that by the same scaffolding process; they can use their skills and knowledge gained from using mobile phones to learn how to use other computing systems, such as personal computers (Kavanaugh, Reese, & Perez-Quinones, 2007). Cobcroft and colleagues support the above research with their claim that mobile technologies within the education context can allow students the opportunity to undertake 'user-led education,' by constructing knowledge, and collaborating with peers and learning communities within and beyond the computer centre (Cobcraft, Towers, Smith, & Bruns, 2006).

Family, friends, digitally literate others and myself were not actual things and not the answer I was expecting when I asked: **what** are you using to help yourself become digitally literate? As with table 13 above, I included these responses in the analysis of the answers to the online questionnaire question and have shaded them red in table 14 above. Five percent of the students either did not understand the question or they saw these human agents as assisting them become digitally competent.

5.3. Assistance in the development of digital competence

Tables 13 and 14, detail **what** the first year pre-service teaching students who completed the online questionnaire were using to help themselves become digitally competent in addition to **who** they were enlisting to help them. Twenty-one percent of the students relied on themselves as is congruent with the literature definition of digital competence being: - the

[11] http://www.pewglobal.org/2015/04/15/cell-phones-in-africa-communication-lifeline/africa-phones-5/

knowledge of procedures and the skill of being able to adapt and learn new procedures. Digitally competent individuals may consider the ability to self-teach, i.e. to learn new programmes or tasks as they are encountered as central to digital competence. It was interesting to explore whether this was in fact the case with my research population, prior to looking at their definitions of digital competence. A notion of independence was implied in the second online questionnaire question: "*what are you using to help yourself become digitally competent*?" with the words **help yourself**.

If students are reliant on themselves to become more digitally competent, it is congruent with the literature definition established in chapter two. In chapter seven, any possible links of self-teaching or self-reliance to the students' digital self-efficacy and their computer attitude levels are presented. Many of the students surveyed responded that they were relying on themselves and were using a digital device such as a laptop, computer, tablet device or mobile phone to assist them become digitally competent. Now that I have explored who and what was assisting the students become digitally competent, I present what the first year pre-service teaching students understood digital competence to be.

5.4. Constructing a definition framework

In order to construct a definition of what it means to be digitally competent, I returned to table 1 in chapter two where I correlated the components of digital competence as identified by Covello, 2010; Eshet-Alkalai, 2004; Hague & Payton, 2010; JISC & Mc Hardy, 2013 and linked them to 21st Century skills (Binkley, et al., 2010). I drew on the components identified by the above authors to develop a framework consisting of six key skills which I used to analyse the students' responses in the online questionnaire when answering the question:

What do you understand the term digital literacy to mean?

Throughout my thesis I use the more encompassing term digital competence to detail what the independent, effective use of digital devices is. As is evident in the two online questionnaire questions specified in the tables above and the third question discussed below, I used the term *digital literacy* rather than digital competence in the online questionnaire as this was a term more common to the student's frame of reference. In table 15 below I detail the six competences that are central to a definition of digital competence. As mentioned above, I focused on four models when drawing up table 15. A rationale, in addition to an analysis of each of the models was provided in table 1 in 2.1.3.

Table 15: Summary of literature definitions of digital competence

Competences	Description	Rationale
Online skills	The ability to read and interpret and create information using ICTs	I draw on Eshet-Alkalai's photo-visual literacy skill of being able to read and understand instructions and messages displayed in visual graphical form. This utilisation of online cues is also mentioned by Covello in his sub discipline, visual literacy. This ability to decipher online media is mentioned by the other authors, yet they also go on to detail the ability to create or produce online information and media. This is linked to the 21st century skill of creativity and innovation (Binkley, et al., 2010).
Information skills	The ability to find, access, evaluate, manage and share information using ICTs	This skill follows on from above and involves critical thinking, questioning and evaluating of information made available through the use of ICTs. Included is not only passively receiving information, but also problem solving. These components fall under the 21st century skills of critical thinking and problem solving as well as information literacy.
Communication skills	The ability to effectively communicate using ICTs	This skill is not detailed by Eshet-Alkalai, yet the other authors view it as the ability to communicate effectively and participate in digital networks. This is linked to the 21st century skill of communication.
Collaboration skills	The ability to collaborate with others using ICTs	This skill can be incorporated into the skill of communication literacy above, but I feel it is a key skill that ICTs users need to have. ICTs have made collaboration easier and it is also listed as its own 21st century skill. Covello has combined this collaboration skill in his sub discipline of computer literacy as did JISC and McHardy. Both Eshet-Alkalai and Future Lab view it as its own skill or component.
Functional skills	The ability to operate digital devices and their relevant applications in the quest to learn and become self-reliant	Eshet-Alkalai is the only author reviewed not to mention having a functional digital ability in his list of literacy skills. It is defined by the others as the actual ability to functionally operate various digital devices. I combined my skill definition with JISC and McHardy's and the 21st century skill of being able to use technology to learn effectively. In addition to this I include the JISC, McHardy's and the 21st century skill of lifelong learning. It may be useful to be able to operate various digital devices, but if these skills do not advance learning and self-reliance then they are meaningless.
Career skills	The ability to use digital devices and relevant applications for increased productivity in the workspace	I initially did not include this skill, identified by JISC and McHardy as career and identity management and listed as the 21st century skill of life and career skills. These are the only 2 authors that mention this skill. However, when analysing the students' definitions of what it means to be digitally literate in the questionnaires, I realise that this is actually an important skill that many of them identify as a valuable one to have.

In the description of each skill, I added the additional clause – *using ICTs* to the description of the first four skills in column two of table 15 above. I reiterate that these skills are for the digital environment. I did not refer specifically to an online environment, because the above

skills were not just skills for an online environment, but ones that could be used in any environment that makes use of digital devices. Emphasis is on skill or ability or competence, rather than knowledge or content.

I used the framework to analyse the students' responses to the question of what it meant to be digitally literate. I analysed each response and assigned it a code as to which competence the student described. Some students indicated more than one ability in their definition and provision was made for this. Therefore, there are 322 responses in table 16 below as 13 of the 307 students indicated more than one competence in their definition of digital literacy. I indicate the initially identified competence of the 307 students in the second column in table 17 that follows and any additional competences in the fourth column. When coding the data, if the students mentioned a second ability, this is indicated by a 2 after the code. For example:

> *Being competent in all digital practices. Being diverse in the use of technology and being able to use devices such as cellphones* [mobile phones], *tablets and computers as a tool to communicate, further understand and research different concepts and topics.* FS, CS_2

Table 16: Coding table for analysing students' definitions of digital literacy

Competences	Description	Code
Online skills	The ability to read and interpret and create information using ICTs	OS
Information skills	The ability to find, access, interpret, evaluate, manage and share information using ICTs	IS
Communication literacy	The ability to effectively communicate using ICTs	CS
Collaboration skills	The ability to collaborate with others using ICTs	COLS
Functional skills	The ability to operate digital devices and their relevant applications in the quest to learn and become self-reliant	FS
Career skills	The ability to use digital devices and relevant applications for increased productivity in the workspace	CARS

I used the students' responses to the online questionnaire question asking the students what they think digital literacy is, to construct an overall definition. I then delved deeper in the data to investigate whether students with differing abilities had opposing ideas of what it meant to be digitally competent. I decided to consider other factors, such as, their computer

attitude, digital self-efficacy, baseline digital literacy result and age to elaborate on and enrich my initial findings.

Table 17: Breakdown of students' responses of their understanding of what it means to be digitally literate

Competences	Number of students initial indication of digital literacy competence (n=307)	Expressed as a percentage of n=307	Including 2nd, 3rd and 4th component of digital literacy definition (n=322)	Expressed as a percentage of n=322
Online skills	36	12%	37	12%
Information skills	17	6%	20	6%
Communication literacy	12	4%	18	6%
Collaboration skills	0	0%	0	0%
Functional skills	211	69%	215	67%
Career skills	3	1%	4	1%
Unanswered	11	3%	11	3%
Confusion with digits	7	2%	7	2%
Other	10	3%	10	3%
TOTAL	**307**	**100%**	**322**	**100%**

I performed an inter-rater reliability test on the coding of the data in table 17. Employing Cohen's Kappa as a statistical measure, a confidence limit of 81% was achieved. This indicated a strong level of agreement between the two data raters.

For consistency I used the same order of competences presented in previous tables 15 and 16 in table 17 above. The majority of students indicated that they found functional skills (highlighted in red) to be a key competence in their understanding of what it meant to be digitally literate. Further discussion of this and the other competences is presented later in section 5.4.1.

Although no students mentioned the importance of collaboration skills, I included it in table 17 above for noting. ICT devices and applications such as wikis and blogs have themselves made collaboration easier. Collaboration is also listed as its own 21st century skill. While Covello combined collaboration in his sub discipline of computer literacy as did JISC and McHardy, both Eshet-Alkalai and Future Lab view collaboration as an independent skill or

component. It is interesting that the first year pre-service teaching students in my research did not mention the ability to collaborate with others as a necessary digital literacy competence. Could this be a mindset inherent from their secondary education? Further research is indicated and as the skill of collaboration does not occur in the practice investigated in my research, I do not include it in tables from this point forward.

5.4.1. Digital competencies

As mentioned in the previous section of this chapter, students did not propose just one skill in their definition of what they thought it meant to be digitally literate. For example, some students indicated that digital literacy included being able to communicate and have good online skills. An example of the coding of such a response was provided in the paragraph directly above table 16 where a student mentioned a second ability in his definition.

While coding the data, it became difficult to differentiate between online skills and information skills. At one stage I considered combining the two abilities of online and information skills under one heading. However, I decided to keep them separate. In keeping with the definition provided in table 16, online skills are the ability to read **and interpret** and create information using ICTs. Subsequently, if the students referred to **just** the skill of reading and writing using ICTs, I allocated the response the code of OS (online skills). Examples follow below:

- *Being able to read, write, understand and express oneself through technology*.
- *Being able to write and read and type through a computer.*

Twelve percent of the students indicated that having good online skills meant they were digitally literate.

In table 16 above, information skills is defined as the ability to find, access, evaluate, manage and share information using ICTs. If the students referred to understanding and interpreting online information, I allocated the response the code of IS (information skills). Examples follow below:

- *Having the knowledge and being able to interpret digital information.*
- *Digital literacy to me means being able to comprehend and make sense of digital visuals and text or audio content.*

Six percent of the students indicated that a key competence of digital literacy was information skills.

Difficulties occurred when I analysed a response such as the one below:

- *The ability to navigate and create information using a range of digital technology.*

The above response and many others referred to both online and information skills. The initial part related to information skills and the second part to online skills which I defined to be reading, interpreting and creating information. I attempted to code the responses objectively and consistently.

Eighteen responses (6%) indicated that the ability to effectively communicate using ICTs was an important part of being digitally literate. Examples of these responses follow below:

- *You are able to go on social media and communicate.*
- *Is to know how to communicate with other people using media device*

The majority of the students, 67%, indicated that functional skills were key to being digitally literate. They viewed this ability to operate digital devices and their relevant applications as significant to being digitally literate. Examples follow below:

- *The ability to use digital technology to produce a desirable output*
- *Being able to coherently control a computer or digital device.*

Career skills and the ability to use digital devices and relevant applications for increased productivity in the workspace were only indicated in 4 responses (1%). An example of such a response follows below:

- *Being able to use most programmes on a computer to aid you in your academic career and to communicate with others*

Unexpected were the responses where students confuse the word digital with the word digits – meaning numbers. As there were a significant number, seven, (2%) I added this component to my table under the category *confusion with digits*. I assumed that these students had not heard the word digital literacy before and did not know what it meant. Of these six students, none rated themselves as advanced computer users. The fact that only two of these students listed English as their home language was a factor that could not be ignored when considering their possible misinterpretation of the words. These responses are as follows:

- *Learn in numbers*
- *The ability to read and write digits and numericals*
- *The understanding of numbers*

- *Reading numbers*
- *It is being literate when it comes to digits*
- *Having the ability to use the numbers, reading the numbers and also knowing their meaning*
- *It is to have knowledge concerning digits*

Eleven (3%) students did not offer a response to the question. I made no assumptions as to this, as the students may have not felt like typing an answer to this open-ended question, rather than not understanding what it meant. The small number of these students was immaterial in the statistics of my whole research project.

Ten (3%) students answered the question in a manner that I could not decipher what they intended to say and indicated these responses as other in table 17 above. Examples of these responses follow below:

- *Literacy that uses technology*
- *Something use to do with cameras as well as satelity*
- *It is the captured data used as a survey*
- *Technology site domain*

I did not feel comfortable allocating these responses to any of the six skill components, so I present them here as anomalies to my research data and include them in table 17 as *other*.

5.4.2. Computer attitude and a definition of digital competence

An analysis of the students' computer attitude levels is presented in more detail in chapter seven. I introduce some of the findings here in chapter five as it was interesting to establish whether there was any correlation between having a positive computer attitude and which competence such a group indicated as being important in their understanding of what it meant to be digitally competent. A breakdown of their responses is presented in table 18 below. As mentioned previously, 13 students detailed more than one competence in their definition of digital literacy. In order to effectively correlate the identified competences and digital self-efficacy levels of the students, I only used the initial competence that those 13 students indicated in their definition (column two in table 17 above). As a result in table 18 below, there is a slight difference from the findings presented in table 17 above. When only taking the initial competence into account as indicated in table 18 below, communication skills dropped from 6% to 4% and functional skills increased from 67% to 69%.

Students' computer attitudes ranged from negative to very positive. No students indicated having a very negative attitude towards computers when completing the Loyd and Gressard computer attitude scale (Appendix B) and for this reason that level is not indicated in table 18 below.

Table 18: Breakdown of students' responses of their understanding of what it means to be digitally literate and their computer attitude level.

Competences	**Number of students**	**Computer attitude level**			
		Negative	**Average**	**Positive**	**Very positive**
Online skills	**36 (12%)**	0	5 (12%)	19 (12%)	12 (11%)
Information skills	**17 (6%)**	0	0	11 (7%)	6 (6%)
Communication literacy	**12 (4%)**	0	4 (9.5%)	7 (5%)	1 (1%)
Functional skills	**211 (69%)**	2 (100%)	27 (63%)	104 (67%)	78 (73%)
Career skills	**3 (1%)**	0	1 (2%)	1 (1%)	1 (1%)
Unanswered	**11 (3%)**	0	1 (2%)	5 (3%)	5 (4%)
Confusion with digits	**7 (2%)**	0	1 (2%)	3 (2%)	3 (3%)
Other	**10 (3%)**	0	4 (9.5%)	5 (3%)	1 (1%)
TOTAL	**307**	**2**	**43**	**155**	**107**

Statistical analysis of table 18 above is provided in figure 12 below. The statistics show that there was no significant relationship between what the students understood digital literacy to be and their computer attitude. The Chi-squared test was explained in more detail in chapter three, the methodology section, of this thesis. These statistics were obtained through the use of statistical analysis software, Statwing, also detailed in more detail in 3.4.3.

Chi-squared test	
P-Value	0.451
Effect Size (Cramér's V)	0.142
Sample Size	**297 excluding - other (10)**

Figure 12: Chi-squared test results of table 18 – students' computer attitude and definition of digital literacy

I conducted the above Chi-squared analysis to determine whether there was any link between a student's computer attitude level and which components of digital literacy they highlighted as important in their definition of digital literacy. My null hypothesis, $H_{0,}$ was the status quo – regardless of computer attitude, the students would choose the same component as important in their definition. H_1, the alternative hypothesis assumed that students with differing computer attitudes would highlight different digital literacy components as important in their definition. For example, a student with a strong attitude may indicate career skills as important, while a student with a weak attitude, may indicate functional skills as important in their definition. As the P (0.451) value in my analysis was greater than 0.05, the initial null hypothesis was not rejected. There was no significant relationship between the two variables – computer attitude and components identified as important in the definition of digital literacy. Likewise, the Effect size (Cramér's V) was close to zero, indicating little association between the variables. The students indicated that functional skills were important regardless of their computer attitude.

The majority of the students surveyed had a positive or very positive attitude towards ICTs. Notably, 69% of students across all four categories of computer attitudes, listed the ability to functionally use ICTs as a key component of digitally literacy. The percentages depicted across the four computer attitude levels in table 18 above are congruent with the original findings in table 17. Two students had a **negative** attitude towards computers. Both of these students indicated that functional skills were a key component of what it meant to be digitally literate. The majority of the n=43 students with an **average** computer attitude also detailed functional skills as being an important component of digital competence, with five mentioning online skills. All five key competencies were mentioned by students with a **positive** attitude. Again, functional skills were highlighted by the majority, 67%, of this group and online skills were indicated by 12%. Students with **very positive** attitudes also mentioned all five competencies. As with the previous three groups of students, the majority, 73%, of the students with very positive computer attitudes, indicated functional skills as being important. Similar to the students with an average and positive attitude, these very positive students also highlighted online skills as being important. However, regardless of a student's computer attitude, they believed that functional skills were a key competence in what they understood being digitally literate to mean.

5.4.3. Digital self-efficacy and a definition of digital competence

As with computer attitude above, an analysis of the students' digital self-efficacy levels is presented in more detail in chapter seven. I introduce some of the findings here in chapter five as it was interesting to establish whether there was any correlation between having a very strong belief in one's own ability and which competence such a group indicated as being important in their understanding of what it meant to be digitally literate. A breakdown of their responses is presented in table 19 below. Students' digital self-efficacy levels ranged from very weak to very strong.

Table 19: Breakdown of students' responses to their understanding of what it means to be digitally literate and their digital self-efficacy level.

Competences	**Number of students**	**Digital self-efficacy level**				
		Very weak	**Weak**	**Mid**	**Strong**	**Very strong**
Online skills	**36 (12%)**	0	2 (14%)	8 (12%)	14 (13%)	12 (10%)
Information skills	**17 (6%)**	1 (33%)	0	3 (4%)	7 (6%)	6 (5%)
Communication literacy	**12 (4%)**	0	0	4 (6%)	4 (4%)	4 (3%)
Functional skills	**211 (69%)**	2 (67%)	12 (86%)	44 (68%)	72 (66%)	81 (70%)
Career skills	**3 (1%)**	0	0	1 (2%)	0	2 (2%)
Unanswered	**11 (3%)**	0	0	1 (2%)	4 (4%)	6 (5%)
Confusion with digits	**7 (2%)**	0	0	0	5 (5%)	2 (2%)
Other	**10 (3%)**	0	0	4 (6%)	3 (2%)	3 (3%)
TOTAL	**307**	**3**	**14**	**65**	**109**	**116**

Statistical analysis of table 19 above is provided in figure 13 below. The statistics showed that there was no significant relationship between what the students understood digital literacy to be and their digital self-efficacy level.

Chi-squared test	
P-Value	0.850
Effect Size (Cramér's V)	0.120
Sample Size	297 excluding - other (10)

Figure 13: Chi-squared test results of table 19 – students' digital self-efficacy level and definition of digital literacy

I conducted the above Chi-squared analysis to determine whether there is any link between a student's digital self-efficacy level and what components of digital literacy they highlight as important in their definition of digital literacy. My null hypothesis, $H_{0,}$ was the status quo – regardless of digital self-efficacy level, the students would choose the same component as important in their definition of digital literacy. H_1, the alternative hypothesis assumed that students with differing digital self-efficacy levels would highlight different digital literacy components as important in their definition. For example, a student with a strong belief in their own digital ability may indicate career skills as important, while a student with a very weak belief in their own digital ability may indicate functional skills as important in their definition. As the P (0.850) value in my analysis was more than 0.05, the initial null hypothesis was not rejected. There was no significant relationship between the two variables – digital self-efficacy level and components identified as important in the definition of digital literacy. Likewise, the Effect size (Cramér's V) was close to zero, indicating little association between the variables. The students indicated that functional skills were important regardless of their digital self-efficacy level.

Three students had a **very weak** belief in their own digital ability. Two of these students indicated that functional skills were a key component of what it meant to be digitally competent and one student indicated information skills. The majority of the n=14 students with a **weak** belief in their own digital ability, detailed functional skills as being an important component of digital competence, with two mentioning online skills. All five key competencies were mentioned by students with a **mid** or average belief in their own digital ability. Again, functional skills were highlighted by the majority (68%) of this group and online skills were indicated by 12%. Students with a **strong** digital self-efficacy level did not make mention of career skills when defining digital competence. As with the previous three groups of students, the majority, 66%, indicated functional skills as being important. Similar to the students with a mid or average digital self-efficacy level, these students also highlighted online skills. The responses of the largest group of students, the ones with a **very**

strong belief in their own digital ability, also covered all five key competences of what it meant to be digitally competent, and as with the previous three groups, highlighting functional skills (70%) and then online skills (10%). As can be seen in table 19 above, functional skills again were highlighted in red as a competence identified by the majority of students regardless of their digital self-efficacy level as key to what they understood digital literacy to be.

5.4.4. Digital competence baseline test results and a definition of digital competence

It was evident from the findings presented in tables 18 and 19 above, that functional skills were highlighted by the students as a core competence of digitally literacy regardless of their computer attitude and digital self-efficacy levels. Table 20 below documents the pass and failure rates of the students when completing the baseline digital competence test and their identification of key competences in their definition of what it meant to be digitally literate.

Table 20: Breakdown of students' responses to their understanding of what it means to be digitally literate and their baseline digital competence test result.

Competences	Number of students	Pass	Fail	Did not take the test
Online skills	**36 (12%)**	19 (11%)	17 (13%)	
Information skills	**17 (6%)**	11 (7%)	4 (3%)	2 (17 %)
Communication literacy	**12 (4%)**	5 (4%)	7 (5%)	
Functional skills	**213 (69%)**	121 (72%)	84 (66%)	8 (67%)
Career skills	**3 (1%)**	2 (1%)	1 (1%)	
Unanswered	**9 (3%)**	4 (2%)	5 (4%)	
Confusion with digits	**7 (2%)**	2 (1%)	4 (3%)	1 (8%)
Other	**10 (3%)**	3 (2%)	6 (5%)	1 (8%)
TOTAL	**307**	**167 (54%)**	**128 (42%)**	**12 (4%)**
		% of n=167	**% of n=128**	**% of n=12**

Statistical analysis of table 20 above is provided in figure 14 below. The statistics show that there was no significant relationship between what the students understood digital literacy to be and whether they passed or failed the baseline test.

Chi-squared test	
P-Value	0.356
Effect Size (Cramér's V)	0.153
Sample Size	285 excluding – other (10) and those who did not take the test (22)

Figure 14: Chi-squared test results of table 20 – students' baseline test result and definition of digital literacy

I conducted the above Chi-squared analysis to determine whether there is any link between a student's result in the baseline digital literacy test and what components of digital literacy they highlighted as important in their definition of digital literacy. My null hypothesis, $H_{0,}$ was the status quo – regardless of whether the students passed or failed the baseline test, the students would choose the same component as important in their definition. H_1, the alternative hypothesis assumed that students who passed the test would highlight different digital literacy components as important in their definition. For example, a student who passed the test may indicate career skills as important, while a student, who failed the test, may indicate functional skills as important in their definition. As the P (0.356) value in my analysis was more than 0.05, the initial null hypothesis was not rejected. There was evidence that there was no significant relationship between the two variables – baseline test result and components identified as important in the definition of digital literacy. Likewise, the Effect size (Cramér's V) was close to zero, indicating little association between the variables. The students indicated that functional skills were important regardless of whether they passed or failed the baseline test.

Again the majority of students identified functional skills as a key competence in their definition of digital literacy regardless of whether they passed or failed the baseline test. The second competence both groups recognised was online skills. None of the students who failed the baseline test mentioned career skills.

5.4.5. Students' ages and a definition of digital competence

Age was mentioned in the literature as a factor that could possibly act as a barrier in an individual's development of digital competence. Older individuals had not grown up in a digital, technological world and this may have impacted on their current ICT acceptance and usage. None of the students surveyed mentioned their age hindering their effective use of ICTs. However, as can be seen in table 21 below, 96% of the surveyed students were below

the age of 30 years old and thus seen to be digital natives. Only one student mentioned her young age as being an enabler in her use of ICTs – table 33 in chapter five. As Czerniewicz, Brown and her fellow researchers point out, age is not necessarily a factor in ICT usage, especially in South Africa, rather access is (Brown & Czerniewicz, 2005, 2007; Czerniewicz & Brown, 2005b; Czerniewicz, et al., 2009).

Table 21: Breakdown of students' responses to their understanding of what it means to be digitally literate and their age.

Competences	**Number of students**	**Age**			
		Younger than 18	**18 - 19**	**20 - 30**	**31 +**
Online skills	**36 (12%)**	0	29 (13%)	7 (10%)	0
Information skills	**17 (6%)**	2 (15%)	8 (4%)	6 (8%)	1 (10%)
Communication literacy	**12 (4%)**	0	7 (3%)	4 (6%)	1 (10%)
Functional skills	**211 (69%)**	10 (77%)	149 (69%)	46 (67%)	6 (60%)
Career skills	**3 (1%)**	0	1 (1%)	2 (3%)	0
Unanswered	**11 (3%)**	1 (9%)	8 (4%)	2 (3%)	0
Confusion with digits	**7 (2%)**	0	6 (3%)	0	1 (10%)
Other	**10 (3%)**	0	7 (3%)	2 (3%)	1 (10%)
TOTAL	**307**	**13 (4%)**	**215 (70%)**	**69 (22%)**	**10 (4%)**

Statistical analysis of table 21 above is provided in figure 15 below. The statistics show that there was no significant relationship between what the students understood digital literacy to be and their age.

Chi-squared test	
P-Value	0.271
Effect Size (Cramér's V)	0.154
Sample Size	297 excluding – other (10)

Figure 15: Chi-squared test results of table 21 – students' ages and definition of digital literacy

I conducted the above Chi-squared analysis to determine whether there was any link between a student's age and what components of digital literacy they highlighted as important in their definition of digital literacy. My null hypothesis, $H_{0,}$ was the status quo – regardless of their age, the students would choose the same component as important in their definition of digital literacy. H_1, the alternative hypothesis assumed that according to their age, students would highlight different digital literacy components as important in their definition. For example, a young student may indicate career skills as important, while an older student may indicate functional skills as important in their definition. As the P (0.271) value in my analysis was more than 0.05, the initial null hypothesis was not rejected. There was evidence that there was no significant relationship between the two variables – age and components identified as important in the definition of digital literacy. Likewise, the Effect size (Cramér's V) was close to zero, indicating little association between the variables. The students indicated that functional skills were important regardless of their age. Age did or did not have any impact. The notion of digital natives and immigrants as according to Prensky was discussed in more detail in 2.2.2.

Thirteen students indicated they were 17 years or younger in the online questionnaire. Of these 13 students, two felt that information skills made up a definition of digital literacy and 10 mentioned functional skills. The majority, 70%, of students surveyed fell into the 18 to 19 year old group. They mentioned skills across the five competencies, with 69% highlighting functional skills and 13% online skills. Similarly, the next age grouping of 20 to 30 year olds also mentioned skills across all five competences, with 67% mentioning functional skills, and 10%, online skills. The last age grouping of 30 years plus consisted of 10 students. These students only detailed three competences: namely information skills, communication skills and functional skills. As with all the other age groupings, the majority of the older group, indicated functional skills as being the main component of digital competence. Most of these older students were representative of Prensky's digital immigrants – born before 1981.

Regardless of age, computer attitude, digital self-efficacy, self-rated digital ability and baseline test result, the majority of the students (69%) surveyed in my research indicated functional skills as the main focus of a definition of digital competence. The following section documents how I arrived at a definition of digital competence for the surveyed first year pre-service teaching students.

Functional skills are defined by the researchers as the actual ability to functionally operate various digital devices (Covello, 2010; Hague & Payton, 2010; JISC & Mc Hardy, 2013). Functional competencies include using digital devices to accomplish tasks, e.g. type an assignment, send an email, listen to music, search for information on the Internet. Many of the surveyed students who detailed digital literacy as a functional skill, used the word: *able to use* or *ability to use* in their definition. An 18 year old female student's online questionnaire response was common to many other students' definition of digital literacy. She described digital literacy as "*the ability to use different means of technology, such as computers, the Internet, cellular phones and other devices or networks*". Such a view is commonplace in today's world, where one needs to accomplish required tasks in the shortest possible time with the least effort. In the same online questionnaire I asked the students if they wanted to improve their digital competence skills and why. Of the 83% who answered **yes**, they wanted to improve their digital skills, 19% said that having better digital skills would make their life easier. Thirty-nine (13%) students answered **maybe** to the same question and one of those 39 students felt that her life would become easier with improved digital skills.

5.5. Arriving at a definition of digital competence

From an analysis of the students' responses to the question: *what do you understand the term digital literacy to mean*, it was apparent that the first year pre-service teaching students considered digital competence to be a functional skill. Two thirds of the students who completed the questionnaire detailed being digitally literate as possessing a certain degree of skill in being able to use a digital device. Online skills were also seen as an important part of digital literacy with 12% of students detailing such a skill as indicative of digital competence. Collaboration was not mentioned at all. The concept of digital competence is much debated and multifaceted, as seen in chapter two in the discussion of the literature. As mentioned earlier in this chapter, a literature definition of digital competence is the set of knowledge, skills and attitudes required when using ICTs to perform tasks, communicate, manage information and build knowledge for work, learning, and socialising (Ferrari, 2012).

Operational skills are a small fraction of the knowledge needed when using ICT devices. Rather, management of information and an ability to use the Internet are seen as very relevant fields. Moreover, critical thinking, creativity and innovation are repeatedly highlighted as essential aspects of digital competence (Ferrari, 2012). Ferrari's, 2012, comprehensive definition can be broken down into several sections. These are learning domains, tools, competence areas, modes, and purposes. Figure 16 below illustrates (in blue) the sections of each part of Ferrari's definition. The majority of the students who answered the question in the questionnaire: ***What do you understand the term digital literacy to mean,*** detailed functional skills (from the definition framework in table 15) as being key to their understanding of what it meant to being digitally literate. Possessing adequate online skills came second with 12% of the students volunteering this in their definitions. The remaining three skills the students mentioned were information skills, communication skills and career skills. Mapping this information (in red) on Ferrari's definition, detailed in figure 16 below, it was evident that the first year pre-service teaching students in my research project focused on a small aspect of a comprehensive definition of digital competence.

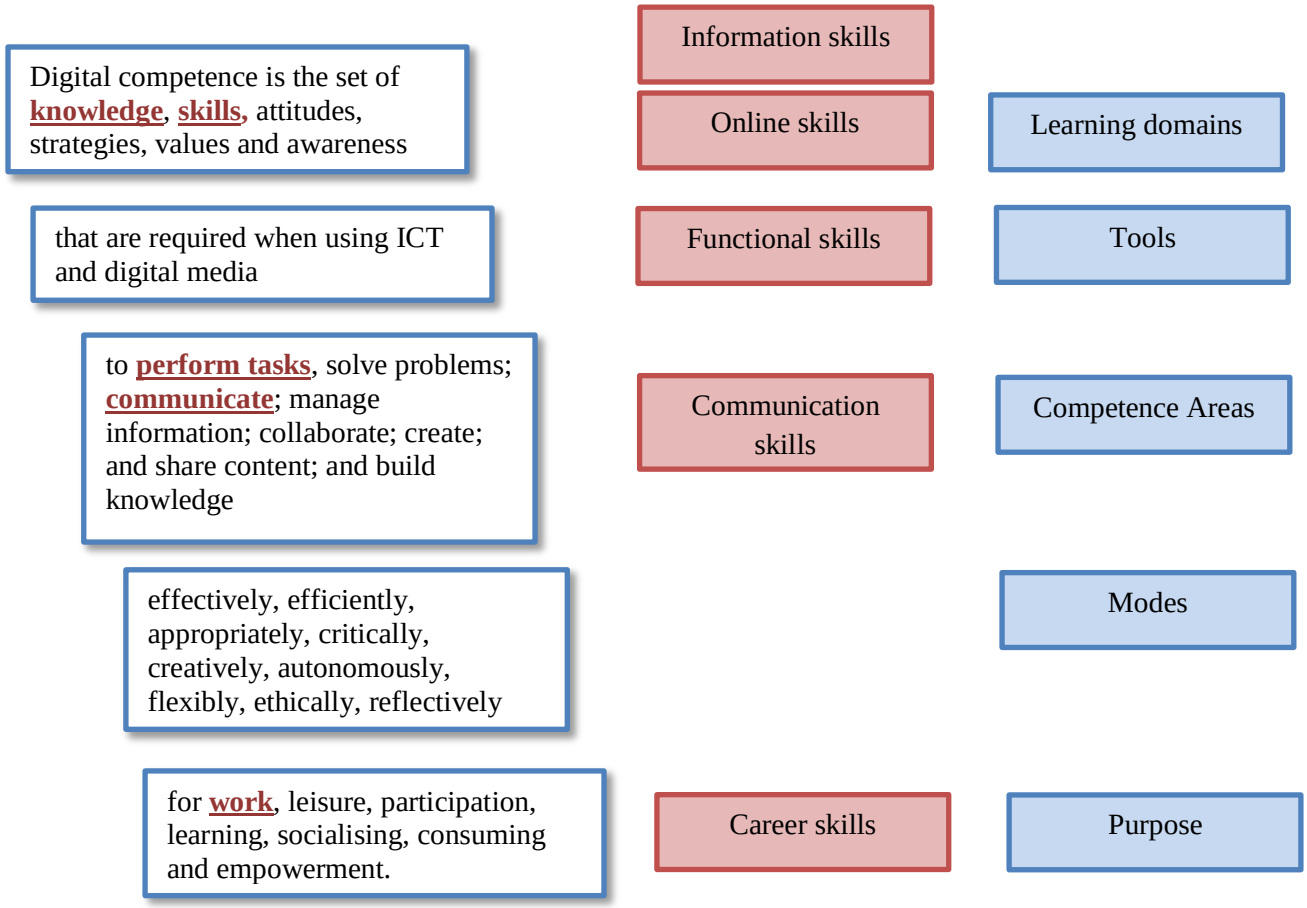
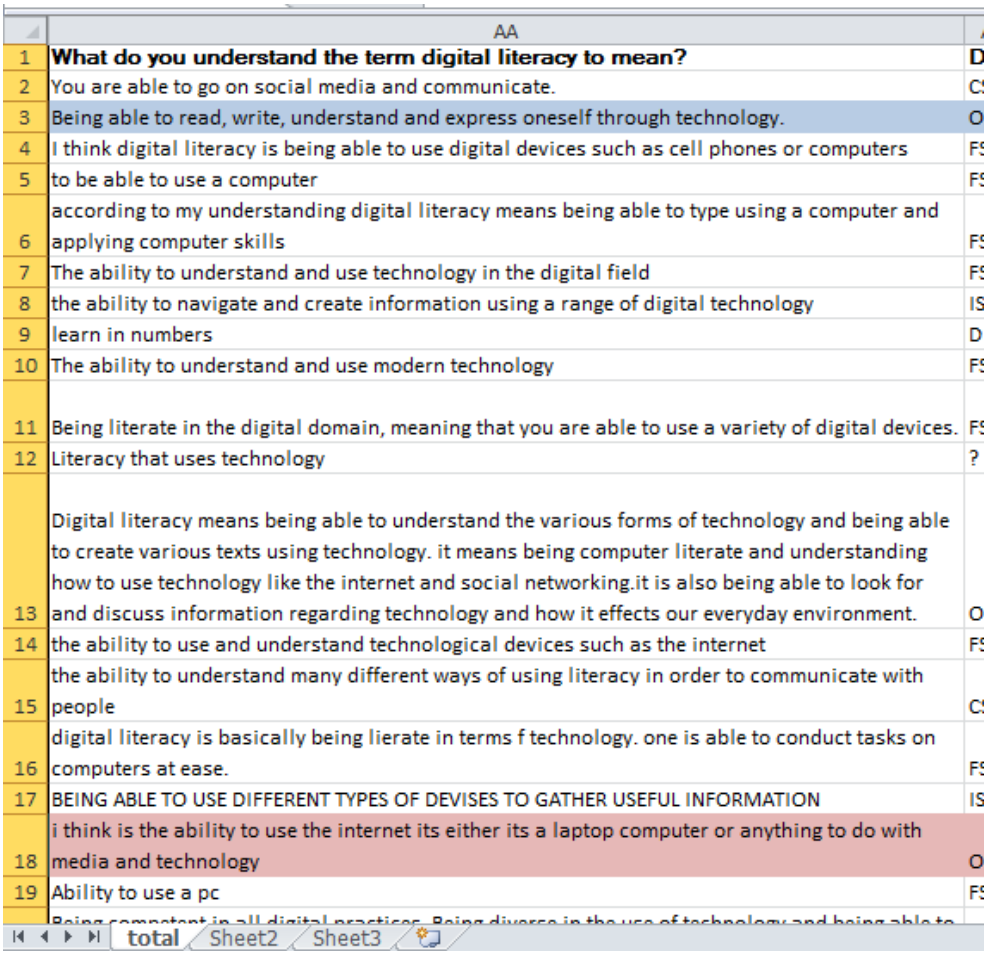


Figure 16: Applying the students' responses in the online questionnaire to parts of Ferrari's (2012) definition of digital competence

In Ferrari's definition it is claimed that digital competence is beyond technical skills, and involves the active application of these skills to aspects of life, namely: work and or professional life, learning, communication, participation in society, leisure and collaborative networking. In drawing up a definition unique to the students who participated in my research, I followed the following steps. Firstly I explored the literature for definitions. I drew up a table 1 summarising the components of digital literacy as presented in Eshet-Alkalai's five literacy skills (2004), Covello's six sub-disciplines of digital literacy (2010), FutureLab's eight components of digital literacy (2010), JISC and McHardy's seven elements of digital literacies (2013), with 21st Century Skills. From this table 1 I extracted six key skills that I used to code the quantitative data elicited from the online questionnaires. Of these six key skills, five were mentioned by the students in their definition of what they thought it meant to be digitally literate. Collaboration skills were not mentioned at all. Emphasis in the students' definitions was placed on functional skills, such as being able to use the ICT device effectively. Lastly I found Ferrari's comprehensive definition of digital competence and overlaid my research findings onto it. Through this process, a definition of digital literacy or competence was drawn up as detailed by the first year pre-service teaching students at the HEI (2013 and 2014). This definition reads:

Digital literacy is the set of knowledge and skills that are required when using ICT devices to perform tasks and communicate for work.

This is a very simplistic definition, yet one that is significant to the students in my study. They identified functional skills as most important in their quest to become digitally competent. The reasons for this thinking and possible implications of their perceptions will be explored in further detail in chapter eight in the unique findings from the interviews of 28 students. Could this simplistic definition be as a result of the nature of the questionnaire and the context in which it was administered? The students were asked to type their definition in the online questionnaire and poor typing skills or a lack of time may have resulted in their simplistic definitions. However, many of the students provided detailed definitions as is evident in a screenshot of my data of the first 19 students' responses in figure 17 below.



	AA	
1	**What do you understand the term digital literacy to mean?**	D
2	You are able to go on social media and communicate.	C
3	Being able to read, write, understand and express oneself through technology.	O
4	I think digital literacy is being able to use digital devices such as cell phones or computers	F
5	to be able to use a computer	F
6	according to my understanding digital literacy means being able to type using a computer and applying computer skills	F
7	The ability to understand and use technology in the digital field	F
8	the ability to navigate and create information using a range of digital technology	IS
9	learn in numbers	D
10	The ability to understand and use modern technology	F
11	Being literate in the digital domain, meaning that you are able to use a variety of digital devices.	F
12	Literacy that uses technology	?
13	Digital literacy means being able to understand the various forms of technology and being able to create various texts using technology. it means being computer literate and understanding how to use technology like the internet and social networking.it is also being able to look for and discuss information regarding technology and how it effects our everyday environment.	O
14	the ability to use and understand technological devices such as the internet	F
15	the ability to understand many different ways of using literacy in order to communicate with people	C
16	digital literacy is basically being lierate in terms f technology. one is able to conduct tasks on computers at ease.	F
17	BEING ABLE TO USE DIFFERENT TYPES OF DEVISES TO GATHER USEFUL INFORMATION	IS
18	i think is the ability to use the internet its either its a laptop computer or anything to do with media and technology	O
19	Ability to use a pc	F

total Sheet2 Sheet3

Figure 17: Screenshot of students' definitions of digital competence

While I cannot negate the findings from this process in my research, digital competence should not be defined primarily as the mastery of technical skills. When planning for and developing digital competence courses, there should be a development of both critical cognitive skills as well as the application of technical skills and knowledge. Cognitive skills include general literacy, such as reading and numeracy, as well as critical thinking and problem solving. The International ICT Panel stated in 2007, that without such skills, true ICT literacy cannot be attained (International Literacy Panel ICT, 2007).

Digital competence has been described as both "complex and fascinating" (Bhatt, 2012, p. 290) and an inherently 'squishy' concept (Chase & Laufenberg, 2011). The diversity of the models I investigated in chapter two suggests that any approach to facilitating digital competence is likely to be as complex and multidimensional as digital competence itself. Digital competence in one course may not mean the same thing in another (McMahon, 2014). The students in my research had a very different idea of what it meant to be digitally competent, exhibiting a strong focus on functional skills. Networks cause actors to construct varying meanings influenced by their relations with other human and non-human actors

(Harrt, 2013) and according to the students surveyed in my research, digitally competence means the possession of a set of knowledge and skills required when using ICT devices to perform tasks and communicate for work. The students in my research constructed this meaning in response to their previous encounters with the non – human actors, - digital devices. Their initial feelings about these devices, their perceived ease of use of, previous experience with and usefulness of the devices also influenced their understanding. Each student's network of engaging with digital devices culminated in their unique definition. As a researcher, I extracted and collated key points from student responses when asked to give a definition of digital competence and constructed a universal definition. Using ANT terms, this definition is black-boxed. I present it as a definition that is representative of the students in my research. However, if one were to open the black box, one would see the various actors and actants that came into play just in this network of me arriving at a definition in answer to research question one. While each student's definition represents one actor within that global definition network, within each student's definition there are a multitude of actors and actants that came into play in order for a student to arrive at their distinctive definition for themselves. In answering research question one, the process of ANT enabled me to draw on reductionist accounts so that I could order what otherwise would have been chaos (Law, 1994).

The section that follows looks at what the students' levels of digital competence were when they entered the HEI in their first year of pre-service teacher training degree – Bachelor of Education.

5.6. Establishing the first year pre-service teaching students' digital competence levels

This section addresses research question two: ***What are the first year pre-service teaching students' current levels of digital competence?*** The data for the analysis of the baseline digital literacy tests was drawn from two groups, a group from 2013 and a group from 2014. As the entire first year group of both years, 2013 and 2014, had to write the compulsory baseline test, I had a large number of results from all the students. However, in total only 307 students completed the online questionnaire. I was most interested in these students as I was able to compare their baseline test results with their computer attitude and digital self-efficacy levels. They completed these computer attitude and digital-efficacy scales as part of the online questionnaire.

The baseline test in 2013 was a component of a Microsoft course. The Digital Literacy Standard Curriculum Version 4 focused on generic ICT skills and concepts. The curriculum featured screenshots and simulations from Windows 8 and Office 2013 to illustrate and provide hands-on examples. It consisted of five modules and 30 multiple choice questions. These questions were part of the online course and designed by the Microsoft online course designers. The questions were randomised and the same as those that the students had worked through at the end of each module when completing a course review. The questions covered the components; computer basics; the Internet, cloud services and the world-wide web; productivity programmes; computer security and privacy and finally digital lifestyles. The students needed to obtain 60% to pass the course. They could take the test at any time during the year and as many times as they wanted. Their highest result was recorded. They decided if they wanted to complete any online training material before taking the test.

A new course co-ordinator took over the administration of the course in 2014 and the baseline test was designed by him. It consisted of 100 multiple choice questions designed using a quiz tool feature of the university's SAKAI platform. These questions covered the same components as mentioned in the 2013 course. The questions were marked automatically and the students received their result on completion of the test. The students needed to obtain 55% and above in order to pass this test. They were not presented with any training or course material prior to this test and it was written in the second week of lectures having commenced. The result from the test gave the course organiser an indication of how many students he needed to cater for physically attending the actual course during the year. Students who passed the course were exempt from attending training sessions. This test is currently still in use (2016).

As mentioned previously in chapter two, when I researched best practice on the assessment of digital competence, there are cases for such an assessment being a simulated one, rather than multiple choice. A simulated situation is one in which the students are placed in an imitation or modeling situation. Such assessments are expensive to produce and require advanced programming. With large numbers, such as those at the HEI, 513 registered first year pre-service teaching students in 2013 and 768 in 2014, practical and or simulated assessments were not a viable option. These took longer to mark and the results of large groups needed to be obtained quickly so that the course organisers could immediately identify which students needed to attend lectures due to them failing the baseline test.

5.6.1. Baseline digital competence test results

All the first year pre-service teaching students were expected to take the online baseline digital competence test. This result was a component of their final course mark. If they received above 60% in 2013 and 55% in 2014, they were exempt from attending the skills lectures. Table 22 below details the pass and failure results of the 2013 and 2014 phase one groups.

Table 22: Pass and failure baseline digital competence test results of the entire 2013 and 2014 groups of first year pre-service teaching students

	2013	**% of 2013**	**2014**	**% of 2014**	**Total**	**Total %**
Total number of registered students	**513**		**768**		**1281**	
Number of students who took the test	478	93%	660	86%	1138	89%
Number of students who took the test and passed	319*	67%	320	48%	639	56%
Number of students who took the test and failed	159*	33%	340	52%	499	44%
Number of students who did not take the test	35	7%	108	14%	143	11%

* The 2013 group was permitted to retake the test as many times as they wanted until they had passed it. They could access the online course material and retake the test when they felt they were ready. They were given 16 opportunities to retake the test over the course of the year. In December 2013, only 54 students still had not passed the test. The final number of students in 2013 who ultimately passed the baseline test is 424. Some of these students retook the test up to seven times. I only included the **first attempt pass results** in my research from this point forward as this corresponds more closely to the conditions the 2014 group were under. The required pass mark for the 2013 tests was 60% and the required pass mark for the 2014 test was 55%. The 2014 group were only given one attempt to take the baseline test. In table 23 below, I detail the pass rate in 2013 for the students who took multiple attempts to pass the test. The table also indicates the multiple times students failed the test. As mentioned above, after table 23, I only consider students who passed the test on their first attempts as having actually passed. The differences in the course over the two year period, was a result of new lecturers and course designers taking over the course in 2014.

Table 23: The multiple attempts at taking the baseline digital competence test of the 2013 first year pre-service teaching students

	2013	**% of 2013**
Total number of registered students	513	
Number of students who did not take the test	**35**	**7% of n=513**
Number of students who took the test	**478**	**93% of n=513**
	Percentage of 478 – total number of students who took the test	
Number of students who passed the test – 1st attempt	319	66%
Number of students who passed the test – 2nd attempt	77	16%
Number of students who passed the test – 3rd attempt	17	4%
Number of students who passed the test – 4th attempt	5	1%
Number of students who passed the test – 5th attempt	1	0.2%
Number of students who passed the test – 6th attempt	3	0.6%
Number of students who passed the test – 7th attempt	1	0.2%
Total number of students who passed the test by the end of 2013	**424**	**89% n = 478**
Number of students who failed the test – 1st attempt	22	5%
Number of students who failed the test – 2nd attempt	20	4%
Number of students who failed the test – 3rd attempt	7	1.4%
Number of students who failed the test – 4th attempt	4	1%
Number of students who failed the test – 5th attempt	2	0.4%
Number of students who failed the test – 6th attempt	0	0%
Number of students who failed the test – 7th attempt	1	0.2%
Total number of students who failed the test by the end of 2013	**54**	**11% n = 478**

As is evident in table 23 above, initially only 66% of the 2013 phase two group passed the baseline test on their first attempt. One student attempted the test seven times before he passed. One student took the test seven times and still did not pass it.

5.6.2. Analysis of baseline digital competence test results

There are a number of factors to bear in mind when looking at the results in table 22 at the beginning of 5.6.1. Firstly, there were more students who took the test in 2013 as they were allowed up until June 2013, to take the test. This was later extended to October 2013. It is possible that a higher percentage of students passed the test on their first attempt for this reason. They could have accessed and gone through the course material and tutorials before taking the test. They would then have had more experience with the ICTs prior to taking the test than the 2014 group who wrote their test two weeks after commencing lectures at the HEI.

Even though the required pass mark for the 2013 test (60%) was higher than the one required in 2014, (55%), it was interesting to note that the overall percentage of pass results in 2013 (73%) was higher than in 2014 (50%). As just over half (57%) of the total first year pre-service teaching groups surveyed in 2013 and 2014 passed the basic baseline digital competence test, I was surprised at the low digital competence levels of the first year students entering the HEI. Furthering the divisional debate mentioned in my introduction in chapter one, I intend to present these findings to my institution and garner support for the continuation of digital competence courses for the first year pre-service teaching students. In the same online questionnaire I asked the students to rate their own digital ability. Using the responses from this question I established who were novice ICT users, beginners, intermediate and advanced users and further enriched the quantitative findings from my data analysis.

5.7. Students' self-rated ICT ability

Table 24 below details how many of the registered students completed the online questionnaire. I work with figures of the students who completed the online questionnaire from this point forward – indicated by the thicker band below. These students provided the necessary demographic information. They also completed the computer attitude scale and the digital self-efficacy scale. The results from these two scales were necessary to explore in conjunction with their baseline digital literacy result. The revised table appears below:

Table 24: Pass and failure baseline digital competence test results of the 2013 and 2014 first year pre-service teaching students who completed the online questionnaire

	2013	**Completed the online q'naire completely**		**2014**	**Completed the online q'naire completely**		**Total 2013 & 2014**	**Completed the online q'naire completely**	
Total number of registered students	**513**	86		**768**	221		**1281**	307	
Number of students who took the test	**478**	83		**660**	212		**1138**	295	
Number of students who passed the test	**319**	61	73% of n=83	**320**	106	50% of n=212	**639**	167	57% of n=295
Number of students who failed the test	**159**	22	27% of n=83	**340**	106	50% of n=212	**499**	128	43% of n=295
Number of students who did not take the test	**35**	3		**108**	9		**143**	12	

In 2013, 124 students completed the online questionnaire. Of these only 86 were fully completed and I discarded the incomplete 38. More students in the larger intake group of 2014 completed the online questionnaire. 252 completed it and only 31 were discarded as being incomplete, leaving 221 to work with. The total number of students who completed the questionnaire fully is 307 and they form the core of my phase one research group.

I focused on the number of students who passed and failed the baseline test over the two years and who fully completed the questionnaire (last three columns in table 24 above) form the core group of phase one students. I concentrated on these students in chapters five, six, seven and eight of my thesis.

In 2013 and 2014 combined, 639 students passed the baseline digital competence test. This accounted for 56% of that student group (highlighted in blue in table 25 below). Of these 639 passing students, only 167 fully completed the online questionnaire. Even though this was only a quarter of the 639 original passing students, interestingly, the passing test result percentage of the focus group of students who completed the online questionnaire fully was one percent more than that of the combined 2013 and 2014 group (57% - highlighted in blue).

Table 25: Extraction of key information from table 24 to be used for further investigation in my study - pass and failure baseline digital competence test results of the combined 2013 and 2014 first pre-service teaching students compared to those who completed the online questionnaire

	Total over 2013 and 2014 who took the baseline test	Total over 2013 and 2014 who took the baseline test % of n=1138	Total over 2013 and 2014 who took the baseline test and fully completed the questionnaire	Total over 2013 and 2014 who took the baseline test and fully completed the questionnaire % of n=295
Number of students who passed the test	639	**56%**	167	**57%**
Number of students who failed the test	499	**44%**	128	**43%**

In 2013 and 2014 combined, 499 students failed the baseline digital competence test. This accounted for 44% of that larger student group. Of these 499 original failing students, only 128 fully completed the online questionnaire. As with the passing students, the percentage results of the smaller failing group are representative of the initial larger 2013 and 2014 failing group of students. Forty-three percent of the students who fully completed the online questionnaire failed the baseline test. This was only 1% less than that of the combined 2013 and 2014 group. The smaller group of students who passed or failed the baseline test AND fully completed the online questionnaire was representative of the greater total number of students as there was only 1% difference in the percentages.

Returning to the students' perceptions of their own ability, I asked them to indicate in the online questionnaire whether they were novice computer users, beginners, intermediate or advanced users. In the online questionnaire four options were presented and the students only selected the one that best described themselves.

- I have never used a computer before
- I am a beginner computer user
- I am an intermediate computer user
- I am an advanced computer user

I used the word computer rather than ICT device(s) as I did not want to negatively influence the responses by the students not understanding what an ICT device was. The results are documented in the section that follows.

5.7.1. Students' self-rated ICT ability and their baseline test result

Following on from the previous findings of the students' baseline test results, I decided to compare the students' actual test results and their self-rated computer ability. I provide these findings in table 26 below.

Table 26: Comparison of students' perceptions of their own ICT abilities and their baseline digital literacy test results

	Total number of students who completed the q'naire and took the test (2013 & 2014) **n=307**	I have never used a computer before **n=25 (8%)**		I am a beginner computer user **n=104 (34%)**		I am an intermediate computer user n=**157 (51%)**		I am an advanced computer user **n=21 (7%)**	
Self-rated ICT users in %			% of n=25		% of n=104		% of n=157		% of n=21
Number of students who passed the test	**167**	1	4%	31	30%	116	74%	19	90%
Number of students who failed the test	**128**	22	88%	67	64%	37	24%	2	10%
Number of students who did not take the test	**12**	2	8%	6	6%	4	2%	0	

Statistical analysis of table 26 above is provided in figure 18 below. The statistics show that there was a strong statistically significant relationship between the students' baseline digital literacy test results and their self-rated ICT abilities.

Chi-squared test	
P-Value	<0.00001
Effect Size (Cramér's V)	0.531
Sample Size	295 excluding the 12 students who did not take the test

Figure 18: Chi-squared test results of table 26 – students' baseline digital competence test result and their self-rated ICT ability

I conducted the above Chi-squared analysis to determine whether there was any link between a student's baseline digital literacy test result and their self-rated ICT ability. My null

hypothesis, $H_{0,}$ was the status quo – there was no link between the students' self-rated ICT ability and their test result. H_1, the alternative hypothesis assumed that the students' test result was related to their self-rated ICT ability. For example, a student who rated themselves as an advanced ICT user was more likely to pass the test, while a self-rated novice ICT user, may fail the baseline test. As the P value in my analysis was less than 0.05, the initial null hypothesis was rejected. There was evidence that there was a strong statistically significant relationship between the two variables – the student's self-rated ICT ability and their baseline test result. Likewise, the Effect size (Cramér's V) was far from zero, indicating a strong association between the variables. The data showed that self-rated intermediate and advanced ICT users were more likely to pass the baseline test than self-rated novice or beginner ICT users. This is discussed in more detail in the concluding remarks within this chapter.

In table 26 above, I indicated the students' self-rated ICT abilities across the four categories of novice user, beginner, intermediate and advanced user (highlighted blue). I indicated the percentage of the total 307 phase one students in the second row of table 26 above. This row was highlighted green. Fifty-one percent of the students rated themselves as intermediate ICT users. Beginner users accounted for 34% of the students, novice users, 8% and the advanced users 7%.

One hundred and sixty-seven students passed the baseline test. One student rated himself as a novice user, yet still passed the baseline test. He was a 19 year old male who passed the test with a result of 73% in 2013. He had a very positive computer attitude of 143 and a strong digital self-efficacy level of 128. Computer attitude and digital self-efficacy are discussed further in chapter seven. The concept of a network of learning proposed by the adoption of actor network theory makes no presumptions as to the factors that may impact on a student's successful learning. While the majority of the students, n=116 (74%) who passed the baseline test indicated that they were intermediate computer users. Most of the students who failed the test n=67 (64%) indicated that they were beginner computer users. 88% of the novice users, those who have never used a computer before, also failed the test.

This was a result that I expected and pointed to the reliability of the students' responses. They did not just click on any option, but thought about their answers. Their self-rated ICT ability indicated the student's prior access and experience with ICTs. The majority of the students rated themselves as intermediate ICT users.

5.8. Concluding remarks

When answering research question one: *What are the first year pre-service teaching students' perceptions of digital competence?* I asked the students via an online questionnaire who was helping them to become digitally literate. A large number, 21%, answered themselves, then went on to mention peers and family members. I also asked the students what they were using to help themselves develop this autonomous use of ICTs. Fifty-four percent answered that they were using a digital device such as a computer to aid them. Seventeen percent mentioned using a mobile phone. Tying in with a historical literature definition of digital competence being the ability to function independently with digital devices, this was quite reassuring.

In my approach to answer the first research question, I further considered all the competences that made up a definition of digital competence as I was interested in establishing to what extent the view of digital literacy the first year pre-service teaching students I surveyed was congruent with this. I tabulated findings from five researchers, (Beetham & Sharpe, 2011; Covello, 2010; Eshet-Alkalai, 2004; Hague & Payton, 2010; JISC & Mc Hardy, 2013) and linked these to 21st Century skills (Binkley, et al., 2010). I analysed the students' responses to my question in the online questionnaire – *what do you understand digital literacy to be?* Using a coding scheme I coded the data and established that the majority of the students' (69%) felt that functional skills are the most important of the six key competences in digital competence. None of the 307 students surveyed felt that collaboration skills were important. I investigated whether age, computer attitude, digital self-efficacy levels, baseline test results or self-rated digital ability impacted on these findings. Regardless of the above mentioned categories, the majority of the students listed functional skills in their answer to the question. This indicated that functional skills – being able to use the digital device independently, was a key skill to possess. I mapped these findings onto Ferrari's comprehensive definition of digital competence and established a definition specific to the group of 2013 and 2014 pre-service teaching students at the HEI. While this definition had a focus on functional skills, digital literacy was defined as ***the set of knowledge and skills that are required when using ICT devices to perform tasks and communicate for work.***

Through the second research question I investigated the first year pre-service teaching students' levels of digital competence as they entered the HEI in 2013 and 2014. In order to answer this research question, I analysed data from the baseline test results completed in

2013 and 2014. I pointed out the different conditions that existed around these tests. I drew on a sample that had both taken the test and fully completed the online questionnaire for my research. It was interesting to note that only 56% of the total first year pre-service teaching students entering the HEI in 2013 and 2014 passed a basic digital competence test. I found a strong statistical significance between a student's baseline test result and their self-rated digital ability. Students who rated themselves as intermediate and advanced ICT users were more likely to have passed the baseline digital competence test. It followed that students' self-rated ICT ability would be closely associated with their digital self-efficacy levels. This is ascertained in chapter seven. It proved interesting to explore correlations between the student's self-rated ICT ability and, or, their digital self-efficacy levels with their baseline test result in chapter seven.

Returning to chapter one where I provided the background and origins of this study, I reiterate that there is a need to address the low digital competence rates of students entering higher education institutions, especially the HEI. A study, such as mine which investigated the possible factors that may impact on these low digital competence levels, will assist course organisers better structure the first year students' engagement with ICTs. In the next chapter I explore the external and internal factors raised by the students as impacting either positively or negatively on their engagement with ICTs. Through following these entities and actors and how they interact within an actor network theory framework, the extended network forces embedded in and acting upon the everyday are revealed (Fenwick & Edwards, 2010).

Chapter 6 - Identifying factors impacting on the development of digital competence

This chapter examines the identification of external and internal factors that may impact on the first year pre-service teaching students' development of digital competence. There were numerous factors identified in the literature. These were listed in table 3 in chapter two. In the online questionnaire I asked the students to identify not only barriers to their development, but also possible enablers, which they highlighted as factors that made it easier for them to effectively use ICTs.

In this chapter, I drew on data from the online questionnaire as well as the interview transcripts to answer my third research question:

> ***Research question 3. What factors inhibit or afford the development of the first year pre-service teaching students' digital competence?***

6.1. Digital competence development framework

I required a model to explore and analyse the barriers that I identified in the quantitative data gathered from the online questionnaire. I investigated frameworks for guiding the evaluation of programmes such as the CIPP Evaluation Model and the Kirkpatrick Model, in addition to the ICT impact assessment model which is an extension of the CIPP and Kirkpatrick Models. I looked at the CIPP model first. The acronym CIPP corresponds to context, input, process and product evaluation. These four parts of an evaluation respectively ask: What needs to be done? How should it be done? Is it being done? Did it succeed? (Adedokun-Shittu & Shittu, 2013). This model is more suited for impact studies like the impact of ICT deployment in teaching and learning in higher education (Wolf, Hills, & Evers, 2006).

Zhang et al. (2011) identified 26 approaches to evaluate projects. In 2008, they themselves used the CIPP assessment model to guide the planning, implementation and assessment of a service-learning tutoring project that was initiated to address the learning needs of pre-service teachers in a project that focused on the needs of at-risk readers in their local school system in Southeastern United States. Zhang et al. argued that the context evaluation component could help identify the service providers' leaning needs, in this case the pre-service teachers, and the community's needs, here being the at-risk readers in the schools (Zhang et al., 2011).

It was an option to use the context evaluation component of the CIPP model in my research to identify which areas of digital competence the first year pre-service students in my research population were lacking in. However, I did not want to use a small part of a model that in its entirety itself did not exactly fit my needs. I continued looking for a model that identified the needs of the students as well as one that detailed an individual's progression from being a novice learner to a mastery level.

Next I looked at the Kirkpatrick Model of Evaluation. This successive four-level model of evaluation is a way of measuring the reaction, learning, behaviour and results that occur in users of a programme to determine the programme's effectiveness (Adedokun-Shittu & Shittu, 2013). Although this model was originally developed for assessing training programmes as with the CIPP model, it could also be useful in assessing the impact of technology integration and implementation in organisations (Lee, 2008; Owston, 2008). This was still not what I needed as I did not evaluate the first year pre-service teachers' digital literacy course's effectiveness in my research.

A blended version of these two models is the ICT Impact Assessment Model which synchronises the CIPP and Kirkpatrick models through the similarities inherent in their elements. It is often used as a conceptual framework for research in impact assessment of ICT integration in teaching and learning and comprises of four components: positive effects, challenges, incentives and integration (Adedokun-Shittu & Shittu, 2013). As is evident in its title, it is a model that looks specifically at the impact of ICT deployment in a specific scenario. As pre-service teachers, the students in my research were required to use ICTs in their studies. They would also need to have reached an adoption level and use ICTs to support administration and teaching and learning when they graduate. My research was not concerned with the impact that ICT deployment in the HEI had on them. Rather, my research focused on their digital competence levels as they entered the HEI and the barriers that they may have encountered in the process of developing digital competence.

The above models are better suited to evaluating ICT programmes and suggesting possible improvements to courses, than to analysing barriers to the development of digital competence. I initially investigated such frameworks for guiding the evaluation of programmes as I anticipated that one of them may provide a suitable model with which to investigate the barriers that the students in my study encounter in their process of becoming digitally competent. I decided not to use an evaluation framework and it was through this

investigative process that I decided to use a model that dealt with skill acquisition and the effective functioning of a learning situation or network, rather than the evaluation of a learning programme.

As I have already stated I believe digital competence to be the development of skills, it follows that it is useful to use a model of skill acquisition to examine how the students achieve a desired level of digital competence. In Dreyfus and Dreyfus's skill development theory, individuals pass through five distinct stages; novice, beginner, competent, proficient and expert (Dreyfus & Dreyfus, 1986). More detail on their model is provided in section 2.5. The South African White Paper on eEducation is an important document in the teacher education institution. It was developed to identify current levels of teacher skill and propose the desired level that a teacher should be able to function successfully within. I used the Dreyfus and Dreyfus model of skill acquisition and the White Paper to design a digital competence frame in table 27 below. This frame helped me identify where the students participating in my research were located. It is interesting to note in which level the students locate themselves and how this related to their actual test results. I designed the digital competence frame by drawing on the components of Dreyfus and Dreyfus' model of skill acquisition (Dreyfus, 2004) while linking this to the guidelines for teacher training and professional development in ICT (Hindle, 2007) detailed in figure 19 below. The White Paper on eEducation, 2004, outlines the ICT development levels that are included in the teacher development framework. These ICT development levels being: entry level, adoption level, adaptation level, appropriation level and innovation level (Department of Education, 2004). There is no later version (checked in September 2016) of this white paper and this is what is currently being used in South Africa with regards eEducation. This White Paper provides a guideline for institutions when designing ICT courses. The Guidelines for Teacher Training and Professional Development in ICT, designed in 2007, is such a document.

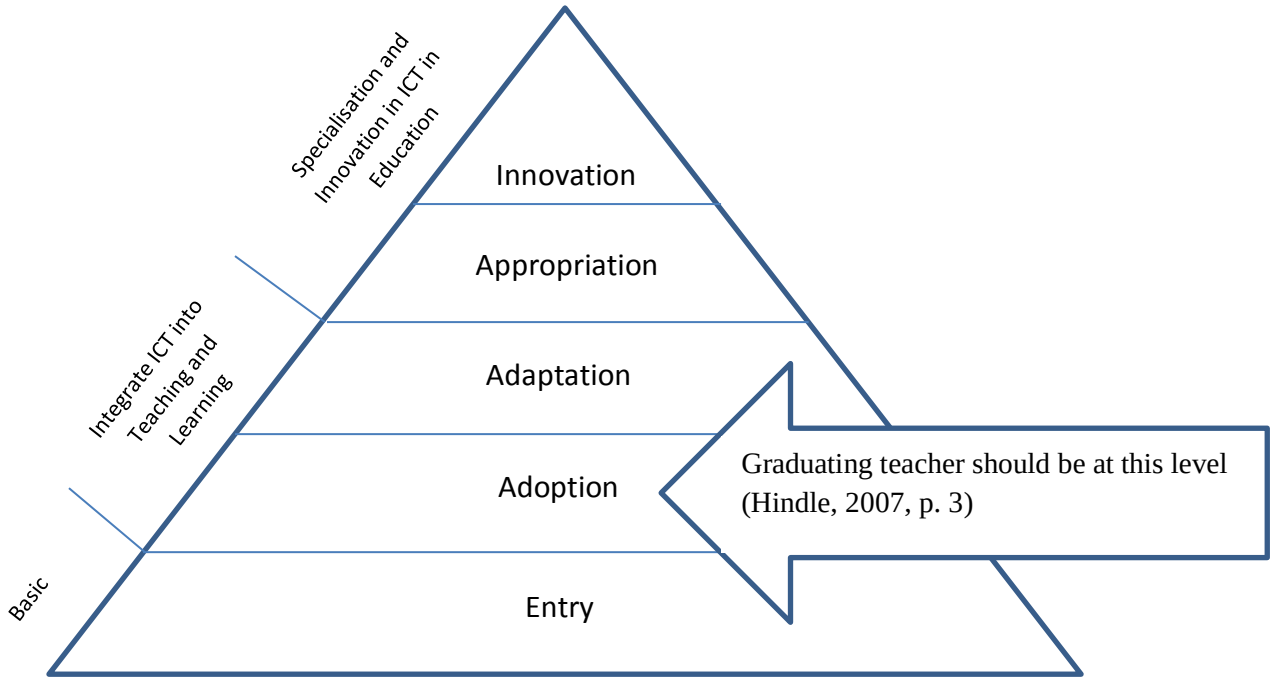


Figure 19: Guidelines for Teacher Training and Professional Development in ICT (Hindle, 2007)

Entry level: The teacher is computer literate and is able to use computers. However, frustrations and insecurities are common in the introduction of ICT. At this level, teachers are likely to lack confidence.

Adoption level: The teacher is able to use various ICTs, including computers, to support traditional management, administration, teaching and learning, and is able to teach learners how to use ICT.

Adaptation level: The teacher is able to use ICT to support everyday classroom activities at an appropriate NCS level, assess the learning that takes place and ensure progression. He/she is able to reflect critically on how ICT changes the teaching and learning processes and to use ICT systems for management and administration. Productivity increases at this level.

Appropriation level: The teacher has a holistic understanding of the ways in which ICT contributes to teaching and learning. He or she has an understanding of the developing nature of ICT, and an awareness that is integral to the structure and purposes of the NCS. He or she has the experience and confidence to reflect on how ICT can influence teaching and learning strategies, and to use new strategies.

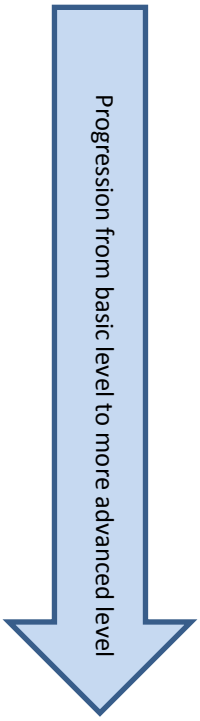
Innovation level: The teacher is able to develop entirely new learning environments that use ICT as a flexible tool, so that learning becomes collaborative and interactive. ICT is integrated as a flexible tool for whole-school development through redefining classroom

environments and creating learning experiences that leverage the power of technology (Hindle, 2007, pp. 6-7).

It is suggested in this framework document, that a teacher should enter the profession at level two - an adoption level as is illustrated in figure 19 above. This implies that the pre-service teaching student should be at a beginner level moving into a more competent level by the time they graduate from the HEI. In table 27 below, I match the very specific guidelines for teacher's ICT development above to an established skill acquisition model. This proved useful as the students participating in my research were pre-service adult teachers and suited a combination of a skill acquisition model such as Dreyfus and Dreyfus's which was developed to explain adult skill development and the ICT development framework.

Table 27: Designing a digital competence development framework

Dreyfus and Dreyfus Model of Skill Acquisition (Dreyfus, 2004)	**Guidelines for Teacher Training and Professional Development in ICT (Hindle, 2007)**	**Digital Competence Frame**
Novice	***Basic level*** Teacher is computer literate	***Basic Novice level***
Beginner	***Adoption level*** Use ICTs to support administration and teaching and learning.	***Beginner Adoption level***
Competent	***Adaption level*** Uses ICTs in everyday classroom activities	***Competent Adaption level***
Proficient	***Appropriation level*** Holistic understanding and use of new strategies	***Proficient Appropriation level***
Expert	***Innovation level*** Develop totally new learning environments using ICT as a flexible tool	***Expert Innovation level***



Individuals progress through five stages in both the model of skill acquisition and the guidelines for teacher development in ICT. In the skill acquisition model, the individual enters the learning situation as a novice and progresses to becoming an expert in the skill. In the guidelines for teacher development in ICT, the teacher enters the area of ICT usage at a very basic level and finally advances to employing ICT devices at an innovative level.

As presented in 5.7, the students were asked to rate their own ICT ability in the online questionnaire. Eight percent rated themselves as novice users, 33% beginner users, 52% intermediate users and 7% advanced users. They were not given a description of what each category implied and I relied on their own self-judgement. Establishing that 45% of the students failed the baseline digital assessment in their first year of study placed at least 45% of the students in the basic novice level of the framework illustrated in table 27 above.

Having identified and established a digital competence framework was not enough. While I had established a framework that the students were likely to progress through, there were students who were not able to successfully advance from one competence level to the next. As a result, the required output of teachers graduating in a beginner adoption level would not be achieved. Forty-five percent of the first year pre-service students had been hindered from developing a basic novice level of digital competence prior to entering the HEI. In my research I contribute to the field of digital competence development by establishing what barriers or factors impact on the students achieving a higher level of digital competence. The students themselves identified these barriers in their answers to the question in the online questionnaire: *What makes it difficult for you to use a digital device?*

6.2. Barriers identified by the pre-service teaching students as impacting negatively on their effective use of ICTs

The barriers that the students detailed as impacting negatively on their engagement with ICTs are presented in table 28 below. These responses were obtained from the online questionnaire data.

As mentioned previously in chapter five, it was necessary to perform an inter-rater reliability test on the coding of this data. Employing Cohen's Kappa as a statistical measure, a confidence limit of 0.80 was achieved. This indicated a strong level of agreement between the two data raters.

Table 28: Barriers identified by the first year pre-service teaching students in the online questionnaire

Barrier	Brief overview	N=307	%
Inexperience	Not having used ICTs extensively in the past	74	24%
Access	Previous and current access to ICTs	51	17%
Blanks	Did not answer the question	36	12%
Nothing	No barrier to their ICT use	32	10%
Software	The software not being 'user-friendly'	29	9%
Software language	Technological jargon and terminology	21	7%
Advancing technology	Including complexity of devices	18	6%
Hardware	Battery life, hardware failure	11	4%
Typing	Not being able to 'touch-type'. Only using two fingers to type.	9	3%
Internet access	Lack of access to the Internet	5	2%
Support	Including material, manuals, information or a knowledgeable teacher	4	1%
Technophobia	Fear of technological or digital devices	4	1%
Physical factors	Eyesight	3	1%
Time	Lack of time to become familiar with the devices	3	1%
Don't know	Unsure of what the barrier could be	2	0.6%
Financial constraints	Lack of finances to buy data or device	1	0.2%
Attitude	Lack of patience to learn how to use a new device	1	0.2%
Undecipherable answers		3	1%

Comparing table 28 above to table 3 in 2.3., which lists the barriers identified in the literature, similarities could be drawn. However, certain barriers were unique to my research population and these had not been mentioned or discussed in the literature. Presentation of the barriers identified in the literature and those distinctive to the first year pre-service teaching students follows in table 29 below.

Table 29: Comparing barriers identified in the literature and by the students in the questionnaire

Barrier identified in the literature	Brief description	Barrier identified by the students
Physical	Access or lack thereof to actual ICT hardware such as a computer, mobile phone, laptop etc.	**Access and hardware**
Digital	Access or lack thereof to relevant online content or software. Not understanding the software programmes	**Internet access and software**
Human	Access or lack thereof to skilled human resources such as a skilled facilitator	
Socio-economic	Refers to the economic resources that one has	**Financial constraints**
Age	Older individuals have not grown up in a digital, technological world and this may impact on their current ICT acceptance and usage	
Language	Access or lack thereof to online content and software in one's home language	**Software language**
Geographic location	Individuals living in rural areas are more likely to have less physical access to hardware and connectivity than urban areas	
Cultural	Certain cultural beliefs may restrict certain individuals' access to ICTs	
Gender	Certain gender beliefs and stereo-typing may restrict certain individuals' access to ICTs	
Race	Legacy inequalities in the South African education system result in wide disparities in participation and access to ICTs	
Illiteracy	An individual's literacy level may restrict their effective use of ICTs	
Computer attitude	An individual's acceptance of and attitude towards ICTs may affect their effective use of ICTs	**Technophobia and attitude**
	Not having used ICT devices extensively in the past	**Inexperience**
	Rapidly changing technological devices including the complexity of the devices	**Advancing technology**
	Not having enough time to learn how to use ICT devices effectively	**Time**
	Eye-strain and deteriorating eye-sight	**Physical difficulties**
	Lack of support materials – manual and instructions	**Support**
	Not being able to 'touch-type'. Only using two fingers to type.	**Typing**

I contemplated merging the two barriers, inexperience and typing together. After considering my own ICT ability, of which I consider myself an experienced ICT user, even though I cannot 'touch type', I decided to keep them as separate factors or barriers. Three percent of the students felt that not being able to type was a barrier to their effective use of ICTs. I felt it significant that they mentioned this barrier specifically and discuss it in more detail later on in this section of this chapter.

I discuss each barrier and provide examples from the students' responses in the online questionnaire to each. Afterwards I explore the interconnectedness of the barriers employing an ANT framework.

The physical factor was also identified in the literature and I grouped the students' responses related to current and previous access in this category. I also included any remarks about problems with hardware. Having access to reliable, functioning hardware is a component of access. Problems with battery power were mentioned by five of the students.

- *"I don't own one"*
- *Not difficult to use. I don't have full access. If I can have my own laptop, I can improve very much"*
- *"From the background that I have we grow up in a very disadvantaged rural area where we access computers once a week until I bought mine."*

The majority of the students stated that their own inexperience was a barrier to their effective engagement with ICTs. This could be a result of their lack of access to ICTs in the past. Possible lack of access may have been due to many other contributing factors such as age, gender, race, geographical location, and even socio-economic standing. The barrier of inexperience could be identified as a human or non-human agent impacting on the learning network of digital competence. It could be a lack of skill within the student and as a result deemed a human actor. Alternatively it could be the result of many non-human actors, such as lack of access to ICTs, financial constraints, irrelevant software and so on. Inexperience was the barrier most noted by the students – 24%. As a result, I decided to explore the students' responses in more depth to investigate whether I could determine the nature of the phenomena of experience. Could I qualify it as a human or non-human actor? At first glance many of the responses indicated that the barrier of inexperience was a human factor. With responses such as: *"I am not used to it. I don't know where and how to use it"* made by a 25 year old male student, I discovered that the majority of the students' responses regarding the barrier of inexperience could be classified as a human actor impacting on the student's network of learning to become digitally competent. Certain responses made by the students referred to non-human factors resulting in their inexperience such as: "*I grew up in a disadvantaged community without computers and other sort of technology stuffs. I am clueless in how to use them"* reported by a 19 year old female student, and "*it is because I have never got the chance to use any digital device before, but I am starting to use now"*

made by a 20 year old female. While the students did not explicitly state what the issues were that resulted in their inexperience, I needed to keep in mind that there were underlying phenomena impacting and resulting in the barrier of inexperience.

Digital factors as identified in the literature included access or lack thereof to relevant online content or software. I also added the students' responses relating to the software being complicated and them not understanding it, for example, *"I don't understand how to close tabs" and "it's usually the different kinds of programmes, softwares and obstacles such as development of viruses and new applications."* I also added the five responses about lack of Internet access such as the following comments: "*where to access the Internet because I don't have a modem*" and "*unavailability of network and/or Internet*." Not being able to understand the software could be related back to their previous inexperience in addition to the possible language factor identified in the literature. One student stated that "*sometimes I don't know where to start and some words I don't know what they mean or what they require to do.*" The students did not mention whether this was because English was not their first language, but the possibility existed that this could be a contributing factor.

Financial constraints identified by the students fell under the socio-economic category identified in the literature. Financial constraints could be a result of numerous other phenomena such as race, gender, or even geographical location. Many other underlying factors existed that impacted on a student's socio-economic status that I cannot even begin to unmask in this discussion. Only one student identified this barrier and referred specifically to their lack of money to buy airtime or data bundles. As the student specifically mentioned their financial constraint in purchasing Internet access, I documented their response under the barrier of financial constraints rather than Internet access problems.

The majority of the students did not speak English as their mother tongue or home language. Most software is designed for English users. Only 22% of the 307 students who completed the online questionnaire spoke English as their home language. South Africa has 11 official languages and table 30 below details the breakdown of the surveyed students' home languages.

Table 30: Home language demographics of phase one students

Home language	N=307	Percentage
isiZulu	102	33%
English	68	22%
Sepedi	35	11%
Sesotho	20	7%
isiXhosa	20	7%
English and Afrikaans	14	5%
Xitsonga	10	3%
Setswana	9	3%
Siswati	8	3%
Afrikaans	6	2%
Tshivenda	4	1%
isiNdebele	4	1%
Other	7	2%

I grouped the unofficial languages under the category *other*. In this category, two of the students indicated that their home language was Italian, one spoke Korean, one spoke Gujariti which is an Indo-Aryan language native to the Western Indian state of Gujarat. Another student spoke Cantonese, another Portuguese and the seventh spoke isiBhaca. This is the Swati language spoken in the area South East of Lesotho. Considering the demographics of the home language of the students, I expected more students to list language as a barrier. It was interesting that all of these students who spoke an *other* language identified inexperience and access as strong barriers.

Seven percent of the students stated that the software language and terminology was a barrier. Two students specifically mentioned software language, "*sometimes I don't know where to start and some words I don't know what they mean or what they require to do."* The others mentioned the terminology and jargon that is used when working with ICTs. *"The different jargon used to operate these devices make it hard to understand how to use the device"* and another student stated that *"their terminology is quite vast and sometimes I cannot seem to understand it."* Brown and Czerniewicz (2007) report in their research findings that students do not comment on the amount of and adequacy of content available in their home language possibly due to the fact that they regard English as the lingua franca of academia and that indigenous languages are regarded to have lesser status. .

I also expected more students to list computer attitude or a belief in one's own ability as a possible barrier. Only one student mentioned attitude when she said she did "*not have the patience and the time to actually read the instructions or learn how to use the device effectively."* Four students stated that they were afraid of damaging the computer or ICT device if they did something wrong. This was made explicit in the following comment: "*sometimes when I want to perform a task I usually don't know where to start and sometimes I am scared that I might damage my phone or the computer if I do what I don't know*."

Unique to this research population were the barriers of inexperience, advancing technology, time, support and typing. I touched on inexperience when previously discussing access issues. As discussed in chapter five, many of the students (39%) were novice or beginner ICT users. Students stated that being at the HEI and doing the ICT competence course was their first encounter using computers. The main theme that seemed to run through the students' responses was summed up by this comment: *"I'm not used to it, I don't know where and how to use it."*

I linked the phenomena of advancing technology and the complexity of the ICT devices together as one barrier. One student stated that "*they constantly upgrading it and you can't always keep up."* An experienced ICT user who had a positive computer attitude and strong digital self-efficacy may take these challenges in their stride. Linking back to the definition of digital competence as being a functional skill rather than knowledge, it followed that a student who was digitally competent would be able to apply their skills in the face of technological advances in the software and hardware they encountered. The following comment illustrated how the phenomena of advancing technology and software could also have been put under the heading of software: "*when upgrades are enforced, such as switching to Windows 7, as it is so different to the others and it takes time getting used to it, which can sometimes result in inefficiency when using the computer, in terms of time and speed of doing the tasks."* As I mentioned before, it was difficult to code this data. I wanted to show enough detail to ensure I did the students justice when they listed the different barriers, yet still group them accordingly so as not to present a splintered account.

Three students said they did not have enough time to work with or practise their ICT skills. One student reported that they found it time consuming and the other said they did not take the time to read the user manuals.

I only included material support in the form of manuals in the category of support. I did not intend for this to include human support – having a more knowledgeable other to help them as this was included in the literature identified phenomena as a human factor. Four students listed this barrier and the following comment best summarised their feelings. *"It is difficult to use a digital device when the instruction manual is not very clear or is missing the some instructions on how to use the device."*

I did not expect typing to factor so highly in this data. One could argue that these comments could be placed under the category of inexperience, but due to the fact that nine students identified being only able to type with one hand and typing slowly as a barrier, I decided to include it as its own barrier in my research. *"Well, the typing is really the issue for me, if I can only learn how to type fast, OMG, I would have gone places."*

Physical difficulties, predominantly eye strain were mentioned by three students. One student also stated that carpel tunnel syndrome hinders her effective use of ICTs. I delved further to investigate the age of these three students and they were 18 and 19 years old. Prior to this I considered the possibility of adding these three responses to the age category, but due to the young age of these students I decided to keep it as its own unique barrier. There were three comments that I could not categorise. The first one was "*I cannot talk to the device*" and the others were "*I'm really lazy and I like simplicity*" and "*key answers*". I indicated these as undecipherable answers in table 29 above.

6.3. Categories of learning barriers

Three studies of categories of learning barriers were presented in 2.3.12. I decided to group the barriers that the students identified according to Darkenwald and Merriam's four general categories of learning barriers in adult learning. The students in my research study were almost adult learners with an average age of 19.6 years and as a result these categories were more appropriate than categories of children's learning barriers. Darkenwald and Merriam's categories of learning barriers have also been used in previous ICT related studies in which Hashim investigated the learning barriers in adopting ICTs among selected working women in Malaysia (Hashim, 2008). In 2009, a study was conducted by Thang, and fellow researchers, with 20 teachers from five Smart Schools in Malaysia. Darkenwald and Merriam's learning barriers were also used here to investigate the barriers that these teachers faced with technology in their teaching situation (Thang et al., 2009). Darkenwald and Merriam's four categories of learning barriers are presented in the heading row of table 31

below. In table 31 below, I map the barriers identified by the first year pre-service teaching students as impacting negatively on their effective use of ICTs onto Darkenwald and Merriam's learning barrier categories.

Table 31: Grouping the factors into the learning barrier categories as defined by Darkenwald and Merriam (1982)

Situational barriers	Institutional barriers	Informational barriers	Psychological barriers
Inexperience (human and non-human agent)			Attitude (human)
Access (non-human)			Technophobia (human)
Financial constraints (non-human)			
Time (non-human)			
Physical factors (human)			
Internet access (non-human)			
Typing skill (human)			
Support (non-human)			
Software and software language (non-human)			

Of the four learning barriers identified by Darkenwald and Merriam, the factor analysis in my research produced just two factors: situational and psychological barriers. The possibility of institutional barriers such as lack of computer labs and appropriate courses at the HEI for the students to access digital devices existed. The students could also have raised the issue of informational barriers such as the institution fails to communicate information on learning opportunities. However, no institutional or informational barriers were identified and as a result these two categories will not be included in further discussion. My study focused on psychological barriers – looking specifically at the role that computer attitude and digital self-efficacy had on a student's development of digital competence. As a result the questionnaire and interview questions were developed to elicit answers related to these categories. The findings presented in table 31 above confirm this. The majority of barriers the first year pre-service teaching students participating in my research encountered appear to be situational barriers. These were specific to each student and not something that the institution may have been able to address or even prevent. However, course organisers should be cognisant of the situational and psychological barriers that the students face both internally and externally and possibly attempt to minimise the impact of these on the first year pre-service teaching students' development of digital competence during their first year at the HEI.

6.4. Levels of self-rated digital competence and barriers

After identifying the barriers that the students encounter when accessing ICTs, I explored whether the novice students experienced different barriers compared to the more advanced students. Table 32 below presents the barriers identified by the students and their self-rated ICT ability.

Table 32: Barriers identified by the pre-service teaching students in the questionnaire according to their self-rated ICT level

Barrier	N=307	%	Novice ICT users	% of n = 307	Beginner ICT users	% of n = 307	Intermediate ICT users	% of n = 307	Advanced ICT users	% of n = 307
Inexperience	74	24%	11	3.5%	35	13%	26	9%	2	0.6%
Access	51	17%	11	3.5%	25	8%	13	4%	2	0.6%
Blanks	36	12%			7	2%	26	9%	3	1%
Nothing	32	10%			4	1%	25	8%	3	1%
Software	29	9%			10	3%	16	5%	3	1%
Software language	21	7%			6	2%	14	5%	1	0.2%
Advancing technology	18	6%	1	0.2%	2	0.6%	13	4%	2	0.6%
Hardware	11	4%			1	0.2%	8	3%	2	0.6%
Typing	9	3%	1	0.2%	6	2%	2	0.6%		
Internet access	5	2%	1	0.2%			3	1%	1	0.2%
Support	4	1%			2	0.6%	1	0.2%	1	0.2%
Technophobia	4	1%			2	0.6%	2	0.6%		
Physical factors	3	1%					2	0.6%	1	0.2%
Time	3	1%			1	0.2%	2	0.6%		
Don't know	2	0.6%			1	0.2%	1	0.2%		
Financial constraints	1	0.2%					1	0.2%		
Attitude	1	0.2%			1	0.2%				
Undecipherable answers	3	1%			1	0.2%	2	0.6%		
TOTAL	**307**	**100%**	**25**	**8%**	**104**	**34%**	**157**	**51%**	**21**	**7%**

Statistical analysis of table 32 above is provided in figure 20 below. The statistics showed that there was a strong statistically significant relationship between the students' self-rated ICT ability and the barriers they identified as impacting on their effective ICT use.

Chi-squared test	
P-Value	0.00146
Effect Size (Cramér's V)	0.318
Sample Size	271 (Blanks - 36 students did not identify any barriers)

Figure 20: Chi-squared test results of table 32 – students' self-rated ICT ability level and barriers to their effective use of ICTs

Needing to determine the existence of a link between a student's self-rated ICT ability level and the barriers they identified as impacting on their effective use of ICTs, my null hypothesis, $H_{0,}$ was the status quo – there was no link between the students' self-rated ICT ability level and identified barriers. H_1, the alternative hypothesis assumed that students with differing self-rated ICT ability levels highlighted different barriers as affecting their effective use of ICTs and ultimate development of digital competence. The possibility existed that an advanced student may indicate access as a barrier to their ICT use, while a beginner student may indicate inexperience as a barrier. The P value in my analysis was less than 0.05, indicating that the initial null hypothesis should be rejected. From the above analysis there was evidence that there was a strong statistical significant relationship between the two variables – self-rated ICT literacy level and barriers to effective ICT use. Likewise, the Effect size (Cramér's V) was close to zero, indicating an association between the variables.

The above analysis shows a statistically high value of intermediate students indicating **nothing** as a barrier. The fact that self-rated beginners indicated nothing as a barrier was a lower than expected result. The number of novice students indicating **access** as a barrier was a clearly statistically higher value than expected. The relationship between the barrier of access and beginners was also high while the value of the relationship between the barrier of access and self-rated intermediate students noticeably lower than expected. The number of self-rated intermediate students who indicated experiencing the barrier of **advancing technology** was significantly higher than expected. Yet the association between the same barrier and beginner students was significantly lower than expected. The relationship between the barrier of **typing** and beginners was higher than expected. Students identified the barrier of **lack of experience**. The number of self-rated intermediate students who

indicated inexperience as a barrier was clearly a statistically low value. Self-rated beginner and novice students' rating of inexperience as a barrier was unexpectedly high.

An overview of each of these factors was provided in table 28 in this chapter and is not repeated here. Reading across each row of barriers in table 32 above, I highlighted in red which group of users; novice, beginner, intermediate or advanced is the largest group to experience that specific barrier. Both the novice and beginner students listed **access** and **inexperience** as their main barriers. Intermediate students also stated that inexperience is a barrier, yet also report that **nothing** acted as a barrier to their learning. The advanced students' responses were wider spread with three students stating issues with **software** and similarly to the intermediate students, nothing being a barrier. Taking the above findings into consideration, regardless of whether the students were novice, beginner, intermediate or advanced ICT users, all experienced situational barriers most keenly. The intermediate and advanced students did not experience barriers as keenly as the novice and beginner students do. Students in both the intermediate and advanced groups stated that they did not experience any barriers at all (9%).

6.5. Applying the ANT framework to identified barriers

Figure 21 below illustrates how I began to apply ANT in an analytical framework to investigate non-human and human actors impacting on a student becoming digitally competent.

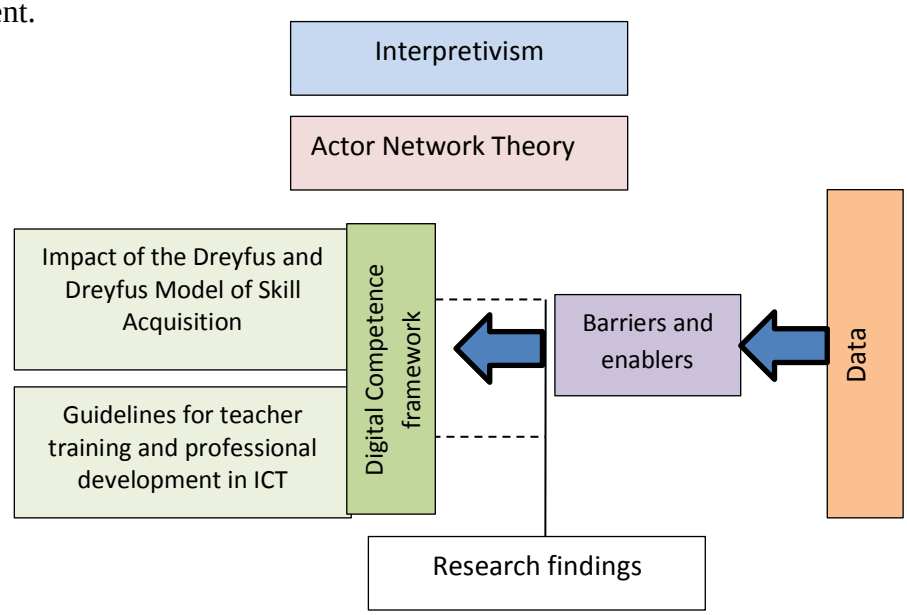


Figure 21: The process of selecting an analytical framework which also considers the possible impact of the Dreyfus and Dreyfus Model of Skill Acquisition and the Guidelines for Teacher Training and Professional Development in ICT including enabling factors and barriers to the development of digital competence on the data analysis process.

From an analysis of the online questionnaire data, I needed to take into consideration the factors that the students identified as both barriers and enablers (coloured purple in the figure below) on their development of digital competence. I conducted an investigation into how these factors impacted on the digital competence framework (coloured dark green). As shown previously in table 31, I combined the Dreyfus and Dreyfus model of skill acquisition (light green) and the guidelines for teachers training and professional development in ICT (light green) into a digital competence development framework.

Employing an ANT framework as explained in chapter four, it was not possible to view the enabler and barrier agents acting on the process of coming to be digitally competent in a linear manner as illustrated in figure 21. Figure 22 below is an extension of figure 21 above, showing the barrier and enabler factors acting as multiple agents within a network or mesh acting on and influencing the entire process.

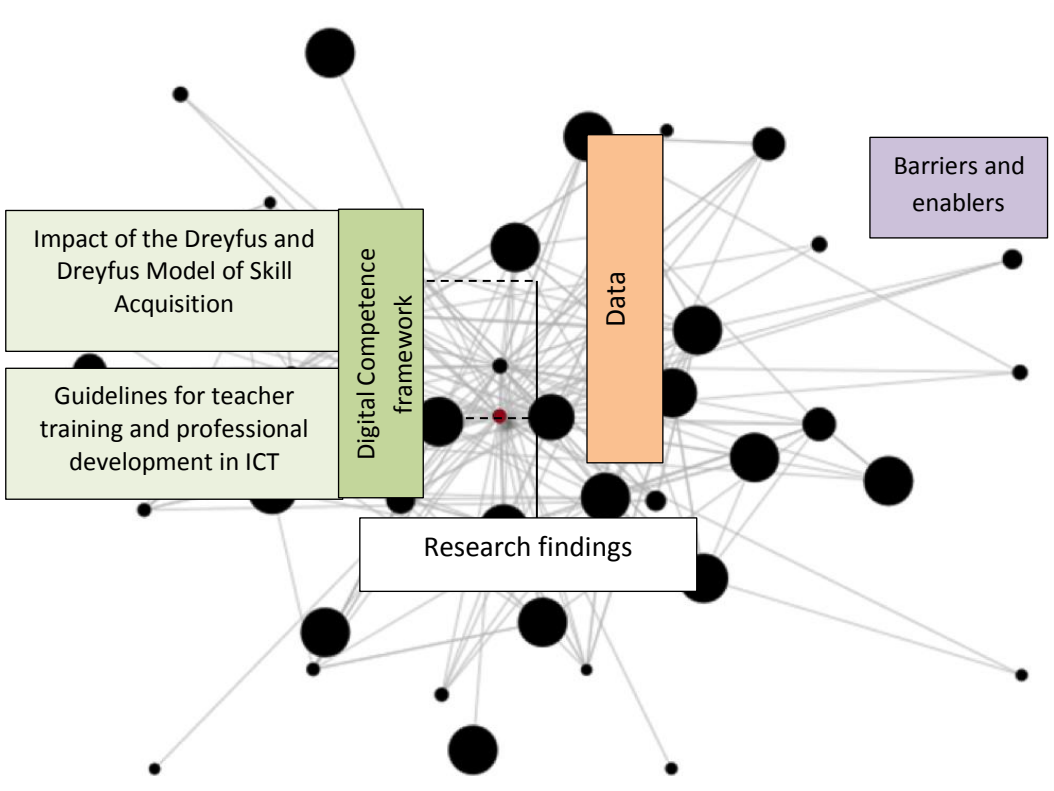


Figure 22: Barriers and enablers to the development of digital competence acting as a mesh / network

The barriers and enablers acted as a mesh impacting on the data in the data analysis process. The barriers and enablers did not act in isolation and these phenomena impacted on each other. Each dot or node in figure 22 above is seen to be a possible enabling or disabling factor in the process of coming to be digitally competent. All these factors or agents impacted on, were connected to, or resulted from one another.

The data was complex and I needed to find a means to enact with this complexity. I drew upon actor network theory to provide a rich ethnographic representation of what the first year pre-service teaching students experienced in their learning network of coming to be digitally competent. One single barrier could not be concluded to be the main barrier that affected a student's engagement with ICTs. Numerous phenomena impacted on each other and the punctualisation of a system. In the data collected from the online questionnaire, no mention was made of the following factors; human, age, geographic location, cultural, gender, race, illiteracy. However, even though the students did not list these, it cannot be ignored that such factors could explain their inexperience in using ICTs, or even their access to ICTs. ANT theorists explain that society consists of networks of any material entity, human or non-human (Ellis, 2013). Both human and non-human elements are considered as equal actors within a network (Cressman, 2009). Agency, or the capacity to act of the actors constitutes the network. I suggest that this also includes the capacity of the actors to act on, create, interact with or change each other. This capacity to act or grant activity to an actor and not the mere connectedness of the human and non-human actors is what makes up the learning network. Literacy, and in my research, digital competence, is an achievement that involves the successful co-ordination of human and non-human actors. Actors or actants are sources of action and could be teachers, other learners, devices or even tests (Gourlay & Oliver, 2014). The actors or actants in my research were the barriers or enablers that impacted on the successful network of coming to be digitally competent.

As explained earlier in chapter four, if everything functions well (punctualisation), a number of networks become substituted by a single element or actor with which the other agents interact. If the actor network breaks down, then depunctualisation occurs. In this case, the blackbox (previously explained in more detail in section 4.3.2) is opened and all the elements are exposed so the one causing the network to malfunction can be identified. The actors have a mutual and causal influence in the network process (Toumi, 2001). In my research, the network of the particular learning environment – coming to be digitally competent, had broken down when a student failed or did not develop the desired level of digital competence. Such a student had not reached stage two (the adoption phase) of the guidelines for teacher training and professional development in ICT as detailed earlier in figure 19 of this chapter six. Depunctualisation had occurred. Through my research and analysis of this process in chapter eight, the black box was opened and I now explored the different agents or situational barriers that were interacting within this network. For example, I identified key barriers and

enablers, such as access to digital devices, a positive computer attitude, etc., that may have affected the successfulness of the learning network or process of coming to be digitally competent.

A key assumption in ANT analyses is that humans are not treated any differently from non-humans. The first year pre-service teaching student is not distinct from any human and non-human agents interacting within the network of learning to become digitally competent. Humans are not assumed to have a privileged a priori status (independent of all experiences) in the world other than to be part of it. This position was first suggested by Bloor and then elaborated on by Latour, and called *symmetry* (Bloor, 1976; Latour, 1987). All everyday things and parts of things – animals, memories, intentions, technologies, bacteria, furniture, chemicals, plants and so on are assumed to be capable of exerting force and joining together, changing and being changed by each other (Fenwick & Edwards, 2010). This area of ANT focused my research when applying an ANT lens to my research findings. I agree that networks are formed and enacted in order for learning to occur, yet the focus on various human and non-human actors is significant. I propose that all the barriers that students encountered in their network are actors in their learning network. These may include past experiences, digital devices, manuals, etc. As agents or actors assemble together, they form associations or networks that keep expanding to extend across broad spaces, long distances or time periods. In the process, such networks can become more or less durable. Exploring the agent or barrier of inexperience further, could result in numerous other actors, such as age, financial constraints, gender and language being identified as possible influencing actors within the student's network of coming to be digitally competent.

6.6. Enablers identified by the first year pre-service teaching students as impacting positively on their effective use of ICTs

Enablers impacting positively on the pre-service teaching student's engagement with ICTs are presented in table 33 below. I asked them what they felt made it easy for them to use ICTs. The following responses were obtained from the online questionnaire.

Table 33: Enablers identified by the first year pre-service teaching students in the online questionnaire

Enabler	Brief overview	N=307	%
Experience	Having used ICTs extensively in the past	98	32%
Accessibility	Previous and current access to ICTs	39	13%
Software	The software being 'user-friendly'	30	10%
Support	Support material or person	30	10%
Device	User friendliness if device itself	21	7%
Nothing	No enabler to their ICT use	15	5%
Portability	Portability of digital devices	11	4%
Self	Curiosity and desire to learn new things	11	4%
Need	Relevance and convenience in life	10	3%
Internet	Internet access	8	2%
Language	Understanding the terminology	5	1%
Commonality	Common applications on different devices	4	1%
Typing	Being able to 'touch-type'	2	0.7%
Age	Being young	1	0.3%
Blank	Did not answer the question	22	7%

Inexperience was listed as a key barrier, but now experience was listed as a strong enabler. It was necessary to perform an inter-rater reliability test on the coding of this data. Employing Cohen's Kappa as a statistical measure, a confidence limit of 82.8% was achieved, indicating a strong level of agreement between the two data raters.

Thirty-two percent of the students listed experience as being the key enabler in their ability to use ICTs. This response linked closely to the barrier of inexperience which they identified as a barrier to their learning. Of these responses 24 (8%) students stated that the factor of inexperience was a barrier and experience was an enabler. The reciprocity of these responses emphasised the importance that the students placed on having used ICTs in the past on their current ability and learning. Experience in this sense implied having used ICTs extensively in the past, with comments such as "*I have grown up in a technologically advanced household"* and "*practicing it makes it easier".*

Thirteen percent of the students noted that accessibility to an ICT device was an enabler. It was interesting to discover that portability of the devices was also seen by the students to assist them in their learning of how to use the ICT device. Comments made by the students in this category related to the accessibility of the device itself. Such as possessing a digital device or being able to use a friend's, or one on the HEI campus. Comments to support this are listed below:

- *"I have my own laptop"*
- *"The availability of computers in public places, such as university and the fact that I own certain devices"*
- *"Is that my friend has a smart phone* [mobile phone] *so sometimes she borrows me"* (sic)

Appropriate software and the fact that generally software was user friendly was identified by 10% of the students as aiding them in their interaction with ICTs. One student summarised it well by stating *"that the cursor on the laptop displays more information about the icon and what it entails. A cellphone is user friendly and comes with a manual, applications that are instilled in the phone make it user friendly."* Ten percent also noted that the support that they received either from an individual or material, such as manuals also helped them. *"People are always there to help and guide me"* and *"when I read the instructions that guide me and make it easy to use"* were two such comments.

The user friendliness of the device itself was seen to assist the students. Seven percent shared responses such as *"it is simple and makes life easier"* and *"clear understandable instructions, easy layout, simple keyboard and bigger, clear screen."*

The novice and beginner students made up the 5% that stated there was nothing that helped them engage positively with ICT devices. Such students seemed quite despondent about their ICT usage with statements like "*up to so far there is nothing easy on my side*" and "*I don't find it easy at all*". Of these 15 students who answered nothing as a possible enabler to their ICT engagement, only two passed the baseline test, one did not write the test and the other 12 failed the test.

Four percent of the students said they themselves were enablers with comments such as "*I am able to learn new things fast and I like to fidget with new devices as I am curious and have an*

interest in them". I felt it useful to comment again here on who the students felt would help them become more digitally competent. This person was an enabler in their situation. As I presented in table 13 in section 5.1., 21% of the students felt they themselves would be instrumental in their development of digital competence. I also asked them via the online questionnaire what they were using to make themselves more digitally literate. In table 14 in section 5.2., it was evident that 17% were using non-human devices such mobile phones and 54% were using computers. These responses were closely linked to the enablers previously discussed and provided elaboration on the actual support both human and non-human that they were receiving.

The need to be able to use an ICT device or component of ICTs was seen as a positive factor impacting on the students' usage of ICTs. Three percent of the students provided comments such as:

- *"They help to make my life easier"*
- *"Things are done quicker and simple"*
- *It is quicker than writing and it is easier to edit your work if it is stored electronically"*

Two percent of the students stated that the Internet helped them. The availability of the Internet and ease of access to it was mentioned.

Only 5 students (1%) commented on the fact that their ability to speak English helped them, yet only 22% of the students reported that English was their home language in table 20. The factor of language was highlighted by a student who said that *"knowing English and understanding the language used in the digital device"* helped him access ICTs more effectively.

The commonality across ICT devices was the "common applications across devices". A student clearly summed it up with her comment that *"many of these technologies are the same or similar to each other in the way they operate, so if you understand how to use one, you will probably know how to use another one."* I think such an ability to transfer skills across various platforms was a key component of digital competence.

Once again the skill of typing which was previously seen to be a barrier, could also act as an enabler. Two students (0.7%) mentioned this enabler. *"Having the background of typing.*

Knowing how to use the Internet. Generally, being able to understand basic typing skills, using the mouse" helps this student access ICTs effectively.

Only one student identified age as an enabler. This 19 year old student said that *"I am still young"*. As with the barriers identified earlier in section 6.2 of this chapter there were numerous enablers that the students identified as enhancing their engagement with ICTs. These factors were as complex as the barriers and should not be seen as acting in isolation and definitiveness on the students' development of digital competence.

6.7. Depunctualisation and the learning network of digital competence

A large number (45%) of the first year pre-service teaching student group failed the digital competence test. Looking at specific students, I explored the possible actors working within the digital competence learning network to isolate the effect possible barriers and enablers had on the process.

6.7.1. Dennis and Sarah

Dennis was an 18 year old first year pre-service teaching student. He failed the baseline digital literacy test in 2014 with a result of 41%. Something in his learning network was not working and depunctualisation had occurred. The black box needed to be opened and the network investigated. As I explained earlier, there is no one singular network, there are many networks acting at one time and constantly shifting and impacting on each other in a learning environment. Dennis rated himself as a beginner ICT user. Being at the HEI was the first time he had been exposed to a computer. He came from a village where there was electricity but no computers. Dennis listed inexperience as a barrier to his effective use of ICTs in the online questionnaire. He felt that devices, specifically a cellphone, would enable his use of ICTs. Sarah was also 18 years old and she also failed the baseline digital literacy test with a result of 50%. Studying at the HEI was also the first time she had access to ICTs. She told me in her interview that there were computers at her high school, but she did not have much access to them stating that "*it was limited time, so we had to do what we had to do at a certain time.*" Both of these students had not had prior access to ICTs before coming to study at the HEI. Interestingly both had low levels of digital self-efficacy or belief in their own ability. This could be a result of their lack of access to and experience with ICTs prior to entering the HEI. Both Sarah and Dennis had positive computer attitudes and they both told me that the emotions they experienced when working with ICTs were positive.

Dennis said that he used to fear computers and now he doesn't. He always saw people when he went to the post office typing fast and asked himself if he would ever be able to do that. He explained how he was so scared, yet now he could do it and felt like he was adapting. In our interview he stated that he always wanted to use a computer and now friends and lecturers were helping him to become digitally competent. Sarah initially did not feel like she needed to be digitally competent when she started studying at the HEI. During our interview she explained that she was now getting used to it and "*kind of enjoys it*". She found it simpler to use ICTs now, yet no one was helping her become digitally competent as all her friends already knew how to use ICTs.

Multiple networks were evident in each of the stories of these two students. While they both experienced situational barriers in their process of coming to be digitally competent, they had different agents impacting on this process. Sarah was a female first year student who owned her own laptop. No one was helping her become digitally competent other than the course she attended at the HEI. She did not feel she encountered any barriers to her learning as she felt that attitude was most important; *"If you have a negative attitude towards it, then it will be harder for you to learn it. But, if it's positive and you actually like it, it will be easier for you to learn."* Initially she felt like everyone was looking at her and seeing how many mistakes she made when she started using ICTs at the HEI. Now that she could copy and paste using the mouse, although not using the '*buttons*', she was not scared anymore. Even though she realised that she typed slower than the rest of the people and that she did the *"whole one finger thing"*, it was fine as long as she got to where she wanted to go. The phenomena or factor of being watched and judged may have only existed at the time that the student interacted with an ICT device. It may have only come into play at that exact moment when she felt that someone was watching her. It may have happened once or on multiple occasions. This agent as well as the agent of her inexperience, positive attitude, age, gender, and only being able to type with one finger all acted together with her network of coming to be digitally competent.

Sarah's story and learning network was different from Dennis's. Through the above narrative account, I illustrated that each student's experience was unique. There were many distinctive agents within each student's experience. While I identified common ones to the first year group that participated in my research, each student's network was a one-off interplay of such agents. Some networks may have had more power than others, some may have existed for a

brief moment, certain networks may have been longer lasting. All came together and resulted in the development of a student's digital competence.

Even the ICT course notes that the student was provided with in their first year pre-service teaching digital competence course at the HEI was an object that embeded a network of curriculum development (course designers, computers, course outcomes) with networks of publication (writers, editors, reviewers, print machines, ink) in a network of distribution across the HEI. All were linked together and the scope of research was limitless. In my research I focused on the barriers that the students were facing in their digital competence learning network. This was one small slice of the actors that may have been impacting on this network of learning. As detailed in the example of Sarah and Dennis above, multiple agents came into play in each student's unique network of learning.

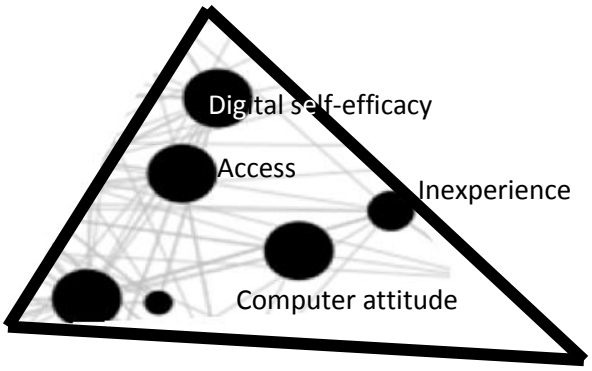


Figure 23: Narrowing of the research process to focus on computer attitude and digital self-efficacy

As evident in figure 23 above, I narrowed my research process even further by focusing specifically on a student's computer attitude and digital self-efficacy in the following chapter seven. The composition of a node or actor is detailed in chapter seven and specific students' learning networks are mapped in detail to present their unique account of learning.

Miettinen (1999) in his critique of ANT points out that if all things in a given network are simultaneously linked to multiple networks and have been created through other networks, there is no immediately identifiable or justifiable object of inquiry. He argues that the network ontology is infinite and therefore unworkable for researchers. However, for Strathern and others, this is simply a question of where to cut the network. I am investigating two aspects of the network – computer attitude and digital self-efficacy which comprise a small portion of the network. The key issue here, is that wherever one puts boundaries around a particular phenomenon to trace its network relations, there is a danger of both privileging that network and thus rendering its multiple supports and enactments invisible

(Strathern, 1996). This is a real concern and one that I was sensitive to. A researcher must be careful not to focus on the most powerful or most visible networks. Nor should the researcher simply reproduce the network participants' views of their reality (Hassard, Law, & Lee, 1999; Lee & Brown, 1994). By representing networks, they become concrete thus implying the realities to be far more stable and durable than actual shifting socio-material relations can ever be. Networks can be objectified as something produced solely in the eye of the researcher and simultaneously forget to paint the researcher's representations into the portrayal of network translations, leaving the entire analysis in control of the researcher. This turns a supposedly heterogeneous, symmetrical perspective into a decidedly human centred one. It also pretends to be capturing uncertainty and complex messiness in what is in effect a predetermined account (Fenwick & Edwards, 2010). I am fully cognisant of this and declare it as a possible limitation to bear in mind when interpreting my research findings. I acknowledge that I focused on the barriers students faced, specifically computer attitude and digital self-efficacy in their learning network of coming to be digitally competent. While looking at the barriers they faced, I also investigated their counterparts – the enablers that made it easy for the students to interact with ICTs.

6.8. Concluding remarks

Initially I thought identifying and commenting on the barriers the students reported on would be a simple task. However, the more I investigated the extent to which they impacted on and were a result of each other, the more difficult the task became. Due to the complexity of the interacting phenomena or agents in a network of learning to be digitally competent, many external factors were identified as contributing reasons as to why a student experiences difficulties in their effective use of ICTs.

In addressing research question three, I investigated which factors inhibited or afforded the development of digital competence. Depunctualisation occurred as only 45% of the students passed the baseline digital competence course. I mapped the ICT developmental levels included in the guidelines for teacher training and professional development in ICT with the components of Dreyfus and Dreyfus' skill acquisition model. This model recommends that teachers graduate from the higher education institution they are studying at in the second level. Graduating teachers in the second level, the adoption level, should be able to use various ICTs to support traditional management, administration, teaching and learning. The teacher should also be able to teach learners how to use ICTs. The digital competence frame

is useful in situating the students in a continuum of skill and identifying the level they still need to achieve. However, a model of skill acquisition indicates a linear progression that the student must pass through until they have achieved mastery. A linear model did not fit my findings and belief that learning is a negotiation of many phenomena and the associations between them. Actor network theory is not a theory of learning, but rather an attempt to explain how learning entails ways of being, ways of acting, ways of feeling, ways of interacting, ways of representing, as well as ways of knowing. These can emerge through the networks and networking practices in which people enrol (Fenwick & Edwards, 2010). Using ANT as a means to explain how a student came to be digitally competent did not sync with a linear explanation of skill acquisition. Learning is not simply an individual or cognitive process, rather it is enacted as a network effect.

Different actors or situational barriers interacting in a first year pre-service teaching student's learning network were identified. The situational barriers of inexperience and access were recognised as the main barriers that led to the breakdown of a student's learning network of coming to be digitally competent. These two barriers are interlinked and inexperience may have resulted due to a lack of previous access to ICTs. An awareness of the identified barriers enables course presenters and organisers to minimise the effect that these may possibly have on the first year pre-service student's experience in the HEI. Complementarily to the identified barriers, 32% of the students identified their previous experience with ICTs as an enabler to their effective ICT use and 13% indicated accessibility to be an enabler. Dennis and Sarah are two students whose unique barriers and distinctive learning networks were presented. Having identified numerous barriers and enablers unique to my research population, I used actor network theory as a framework for analysis. I continue my focus on the two sub question of research question three in the following chapter seven. The two sub questions explore the phenomena of computer attitude and digital self-efficacy and their impact on a student's development of digital competence.

Chapter 7 - Computer attitude, digital self-efficacy and the development of digital competence

Chapter seven addresses the two sub-questions of research question three. These questions relate to the first year pre-service teaching students' computer attitudes and levels of digital self-efficacy. I present findings from the students' completion of Loyd and Gressard's computer attitude scale and Murphy's digital self-efficacy scale in the online questionnaire. Possible correlations between a student's attitude and belief in their own ability and their success in the baseline digital competence test are explored. Possible links of self-teaching or self-reliance to the student's digital self-efficacy and their computer attitude were examined. The students provided reasons why they would or would not like to improve their digital competence in response to a question in the online questionnaire. Any correlations between their answers and their computer attitude and, or, digital self-efficacy were investigated. I also explored possible associations between computer attitudes and digital self-efficacy levels. The two sub-questions focused on in this chapter are:

> ***Research question 3a. What relationship is there (if any) between computer attitude and a student's attainment of digital competence?***
>
> ***Research question 3b. What role does a belief in one's own ability to use ICTs (self-efficacy) play in the development of digital competence?***

The enabling or prohibiting role that the factors of computer attitude and digital self-efficacy play on a first year pre-service teacher's development of digital competence formed the core focus of my research project. I enquired whether a positive or negative computer attitude helped or disadvantaged an individual's development of digital competence. As presented in section 2.4.1., having a positive attitude is likely to enhance the learning process, while a negative attitude may lead to computer resistance. An individual's attitude towards computers and related technology could determine his or her performance with the technology (Jawahar & Elango, 2001; Seymour & Fourie, 2010; Shneiderman, 1980). An individual can have a strong or weak belief in his or her own digital ability. Digital self-efficacy influences an individual's choices about which behaviours to undertake. This self-efficacy includes the effort as well as the persistence exerted in the face of obstacles to the performing of and the ultimate mastery of behaviours (Compeau & Higgins, 1995).

There is a tendency in educational research to focus on relations, as though seeking lines of coherence, causality and connection rather than to acknowledge the incoherence, disparateness and odd alignments of disjuncture (Fenwick & Edwards, 2010). Having such a narrow perspective and preoccupation with network relations can result in researchers losing sight of the more interesting or puzzling messiness of educational phenomena. As I pointed out in chapter six when exploring the barriers and enablers impacting on a student's development of digital competence, the importance of understanding entities and forces as effects should not be downplayed. Rather more open and richer explorations of the multiple forms as they come together in different ways, in connections, disconnections, partial connections and non-connections to produce these effects is encouraged (Fenwick & Edwards, 2010). Quantitative results from 307 students measuring their computer attitude in addition to their digital self-efficacy when they completed Loyd and Gressard's computer attitude scale and Murphy's digital self-efficacy scale have been analysed in this chapter. Five out of the 307 students surveyed explicitly identified attitude as a possible barrier to their effective use of ICTs or digital devices.

Up to this point I wanted to categorise and compartmentalise the data findings. My research was now starting to get "messy". I obtained results from my data analysis that I had not anticipated. Results were not congruent with what I had read in the literature and what I had initially hypothesised. I came to the realisation that possessing a positive attitude and a strong belief in your own digital ability was not necessarily a pre-determining factor to successful development of digital competence. I found that every student had a unique and original story to tell about their learning network. As I searched for commonalities in order to draw conclusions and make generalisations, I started losing sight of the more interesting or puzzling messiness of my research as mentioned by Fenwick and Edwards. I decided to embrace this new track that my research was taking. The more I investigated actor network theory the more I realised that this *off track* stance that my research was taking was acceptable and exciting. My analytical framework of ANT allowed for the messiness of my research findings, in fact, it welcomed it.

7.1. Computer attitude

Findings regarding barriers to the effective use of ICTs were presented and discussed in chapter six. Results were obtained from the data provided by the first year pre-service teachers when answering the online questionnaire, specifically the question: *What makes it*

difficult for you to use a digital device? Many of the barriers were situational barriers as detailed in table 31 in section 6.3. The students had little control over these external, situational barriers which included inexperience, access, support material and time. The factors or agents of computer attitude and digital self-efficacy were not specifically mentioned by the majority of the students as barriers, except for four students who listed technophobia and the one student who noted his attitude as a possible barrier. I placed the barriers of technophobia and attitude under the section of psychological learning barriers in the previously mentioned table 31 presented by Darkenwald and Merriam (1982) in their book on foundations of practice in adult education.

Computer attitude is a way of thinking and behaving and is an individual's attitude towards using a computer. A positive attitude is likely to enhance the learning process, while a negative attitude may lead to computer resistance. An individual's attitude towards computers and related technology could determine his or her performance with the technology (Jawahar & Elango, 2001; Seymour & Fourie, 2010; Shneiderman, 1980). Teo, Lee, & Chai (2008) state that computer attitude may act as either a facilitator or barrier to computer use, with consequences for students' learning. Studies have shown that computer attitude is influenced by different variables which include perceived usefulness of the technology, computer confidence, training, gender, as well as, knowledge about computers. In addition to these, computer anxiety and liking, as well as computer experience impact on an individual's computer attitude. Teo, et al. (2008) point out that these factors interact with one another to impact on the individual's attitude towards computers. Research has shown that a positive attitude has the ability to predict future computer usage (Myers & Halpin, 2002; Schunk & Pajares, 2002; Shapka & Ferrari, 2003; Yildirim, 2000). Computer anxiety on the other hand is a negative attitude towards computer usage, and is defined as the apprehension felt by individuals when they use computers, or when they consider the possibility of computer utilization (Simonson, Maurer, Montag-Torardi, & Whitaker, 1987).

Findings from other studies indicate that computer anxiety may be a modifiable condition based on negative correlation with prior experience with digital devices (Charlton & Birkett, 1995; Leso & Peck, 1992; Loyd & Gressard, 1984). There are studies that show that more computer experience and training actually improves computer attitudes. Beckers and Schmidt (2001) used a six-factor assessment of computer anxiety on 184 first year Dutch Psychology students at a Netherland's university. They found that self-efficacy contributed

to digital competence and that training programmes that enhance self-efficacy and digital competence may in principle reduce computer anxiety (Beckers & Schmidt, 2001). Levine and Donitsa-Schmidt administered questionnaires to 309 Grade 7 to 12 school children. They argue that beliefs lead to attitudes which are a precursor to behaviour. They found that computer use had a positive effect on computer self-confidence and computer attitudes. These ultimately positively effected the development of computer competence (Levine & Donitsa-Schmidt, 1998). More recent studies reveal similar findings. 471 pre-service teachers were surveyed in Turkey. Attitude to technology, perceived computer self-efficacy and computer anxiety were found to be important predictors of the pre-service teachers' attitude towards integrating ICTs in his or her teaching (Celik & Yesilyurt, 2013). The variables of perceived usefulness, perceived ease of use and technological complexity, were found to be significant predictors on attitudes towards computer use in a Serbian study of 419 pre-service teaching students. Gender and age were found to have no significant influences on their attitudes (Teo, Milutinovic, & Zhou, 2016). A study looking at computer anxiety and attitude towards computers and the Internet in Romanian high-school and university students showed that low digital self-efficacy predicted anxiety. An individual's lack of previous education in digital competence had direct negative effects on computer anxiety and on the negative attitudes towards the Internet (Cazan, Cocorada, & Maicon, 2016). Findings from my research in section 7.3. better inform the link that computer attitude has to self-efficacy. In section 7.1.2.1., I also investigate whether attitude acts as either a barrier or enabler that the students face when accessing ICTs.

7.1.1 Measuring computer attitude

Loyd and Gressard Computer Attitude Scale (Appendix B)

The Computer Attitude Scale (CAS) was discussed in detail in section 3.3.2.1. As is appropriate for a four point Likert Scale, the distance between each interval or attitude level is equivalent with an average attitude of a score between 88 to 111 points in the CAS being the midpoint. The intervals for the computer attitude scale are as follows:

Very negative attitude	40 to 63 points
Negative attitude	64 to 87 points
Average attitude	88 to 111 points
Positive attitude	112 to 135 points
Very positive attitude	136 to 160 points

7.1.2. Findings from the computer attitude scale

The majority (85%) of the 307 students had a **positive** or **very positive** attitude towards using digital devices. None of the students exhibited a **very negative attitude** and only two students indicated that they had a **negative attitude**. One of these two students passed the baseline digital literacy test and the other failed the test with a mark of 45%. These findings are presented in the graph in figure 24 below.

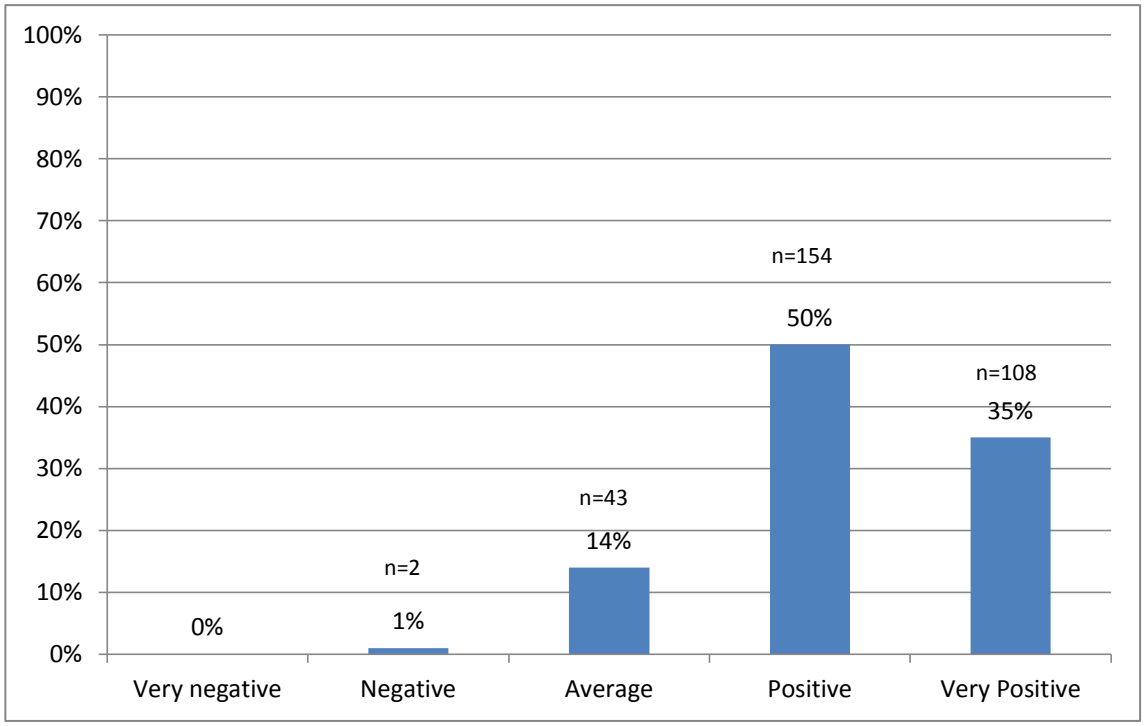


Figure 24: Computer attitude levels of first year pre-service teaching students

A descriptive statistical analysis of the graph in figure 24 above is provided in figure 25 below. The statistics showed that the average score of the 307 students was 129, which fell in the positive attitude range towards computers.

Descriptive statistical analysis	
Median	130
Average	129
Confidence interval of average	126.86 to 130.33 (± 1.74) on either side of the average
Standard deviation	15.4
Minimum	73
Maximum	160
Sample size	307

Figure 25: Descriptive statistical anaylsis of graph in figure 24 – students' computer attitude levels

The confidence interval was narrow indicating a 95% confidence in the true value of the average. From an analysis of the findings from the data of the 307 phase one students' computer attitude scores, I drew consistent conclusions from the data findings. Similar students, that is, any of the other first year pre-service teaching students that did not participate in my research, completing the same assessment, were expected to score within 1.74 lower or higher than the average of 129 with a 95% confidence level and 5% of the students will not. Standard deviation is a measure of the dispersion of the computer attitude scores. The coefficient of variation (CoV) is calculated by dividing the standard deviation result by the average and represents the ratio of the standard deviation to the average. This indicated that students' scores were within 12% of the average or expected value of the results. This showed that most of the students scored themselves within the range of having a positive computer attitude.

7.1.2.1. Computer attitude and baseline test result

Table 34 below illustrates the correlation between the students' computer attitudes and their baseline test results.

Table 34: First year pre-service teachers' computer attitude levels and test results

Computer attitude level	Pass	Fail	Did not take test	**Total**
Very negative attitude	0	0	0	**0**
Negative attitude	1 (50%)	1 (50%)	0	**n=2 (1%)**
Average attitude	26 (60%)	15 (35%)	2 (5%)	**n=43 (14%)**
Positive attitude	73 (47%)	77 (50%)	5 (3%)	**n=155 (50%)**
Very positive attitude	67 (63%)	35 (32%)	5 (5%)	**n=107 (35%)**
Total	**n=167 (54%)**	**n=128 (42%)**	**n=12 (4%)**	**307**

I highlighted in red whether the majority of each computer attitude group passed or failed the test. It is evident from table 34 above that more students with an **average** computer attitude (60%) passed the test, while fewer students with a **positive** attitude passed than those that failed. The literature presupposes that students with a **negative** or **average** attitude would be less likely to perform well in the baseline digital competence test. Findings from the above data suggest otherwise. The majority of the students (n=262 or 85%) had a **positive** or **very**

positive attitude towards the use of digital devices. Exploring table 34 in more depth by combining the findings from the students with **positive** and **very positive** computer attitudes, I found that the 73 students with a **positive** attitude and the 67 students with a **very positive** attitude who passed the test only accounted for 53% of the total number of the above mentioned majority of students with **positive** and **very positive** attitudes. This indicated that a **positive** attitude in my research population of first year pre-service teaching students at the HEI in 2013 and 2014, had little impact on them passing or failing the first year digital competence test. Statistical analysis of table 34 above is provided in figure 26 below. The statistics confirm that there was no significant relationship between a student's computer attitude and their baseline test result.

Chi-squared test	
P-Value	0.199
Effect Size (Cramér's V)	0.118
Sample Size	307

Figure 26: Chi-squared test results of table 34 – students' test results and their computer attitude level

Needing to determine whether a student's computer attitude level was an indicator to the first year pre-service teaching students' passing or failing of the baseline digital competence test, my null hypothesis, H_0, was the status quo – computer attitude level was not an indicator of success. H_1, the alternative hypothesis assumed a student with a positive attitude was more likely to pass the test than one with a negative attitude. The P value in my analysis was greater than 0.05, indicating that the initial null hypothesis be accepted. From the above analysis and from my discussion of table 34 above, having a positive computer attitude was not a strong indicator of the students' success in the baseline test.

Interestingly the highest mark attained in the baseline digital competence test was 92%, achieved by an 18 year old female student, Fazel. She only just classified as having a **positive** attitude towards digital devices with a score of 112 on the computer attitude scale. The student with the lowest result is a 21 year old male, Sinsi. He failed the test with a result of 18%. He rated his computer attitude slightly higher that Fazel's, scoring himself 118. Furthermore, they both have an **average** belief in their own ability with Fazel scoring herself 103 and Sinsi, 104. A belief in one's own ability or digital self-efficacy (DSE) is discussed in more detail in the section that follows. It is important to point out, that here are two

students, one of which achieved the highest mark and one who achieved the lowest test result, yet they have similar computer attitudes and digital self-efficacy scores.

Fazel and Sinsi may be outliers, that is, their results seem to be quite different from the rest of the research population. Outliers refer to data or observation points that fall far outside the main distribution of scores. Some researchers maintain that valid outliers should be dropped, while others believe they should be included (McMillan & Schumacher, 2006). I mention Fazel and Sinsi here as they are key examples of my findings through an application of ANT that each student's learning network is different. Their learning networks have differences and similarities. Their stories illustrate that no one single phenomena or agent impacts on an individual's process of coming to be digitally competent. Each student has their own "story to tell" when describing the network that they interact within. In ANT analyses, there is often reference to humans and non-humans as though there is a distinct boundary separating the two. However, the distinction is far less clear. "A human being is not an autonomous clump of emotions, intentions, memories and acquired skills in one isolated sack of skin, because these elements are each shaped and inscribed by non-human things" (Fenwick & Edwards, 2010). **Attitudes** and **beliefs** may impact on an individual's network of learning. My initial assumption when embarking on my research project was flawed. A student with a high computer attitude (CA) or strong level of digital self-efficacy (DSE), or both, may not necessarily be more digitally competent or more likely to have passed the initial baseline digital competence test than a student with a negative computer attitude or weak belief in their own ability.

7.1.2.2. Correlation between computer attitude and self-rated ICT ability

In table 35 below, I present data from the online questionnaire responses. The students were asked to rate their own ICT ability. They indicated whether they were novices, beginner users, intermediate or advanced users. The self-rated ICT ability findings are presented in table 26 in section 5.7.1., and are drawn on here to establish if there is any correlation to the students' computer attitudes.

Table 35: Computer attitude levels of first year pre-service teachers and their self-rated ICT ability

Computer attitude level	Novice ICT user	Beginner ICT user	Intermediate ICT user	Advanced ICT user	Blanks	**Total**
Very negative attitude	0	0	0	0	0	**0**
Negative attitude		2 (100%)				**n=2 (1%)**
Average attitude	4 (9%)	15 (35%)	21 (49%)	2 (5%)	1 (2%)	**n=43 (14%)**
Positive attitude	16 (10%)	63 (41%)	71 (46%)	5 (3%)		**n=155 (50%)**
Very positive attitude	5 (5%)	23 (21%)	65 (61%)	14 (13%)		**n=107 (35%)**
Total	**n=25 (8%)**	**n=103 (34%)**	**n=157 (51%)**	**n=21 (6%)**	**n=1 (1%)**	**307**

Reading across the table rows, the areas highlighted in red indicate where the **majority** of students in each computer attitude level scored themselves with regards to their self-rated ICT ability. The two students who indicated they had a **negative** attitude were beginner ICT users. The majority of the students (49%) who had an **average** attitude were intermediate ICT users. This is similar to the students with a **positive** attitude also stating they were intermediate ICT users (46%). Sixty-one percent of students with **very positive** attitudes also rated themselves as intermediate ICT users.

The majority of both the self-rated novice (n=16), beginner (n=63) and intermediate (n=71) ICT users had **positive** attitudes towards ICTs. The majority of the self-rated advanced (n=14) ICT users had **very positive** attitudes towards ICTs. Statistical analysis of table 36 above is provided in figure 27 below. The statistics show that there was a statistically significant relationship, with a small effect size, between the students' computer attitude and their self-rated ICT ability.

Chi-squared test	
P-Value	0.00225
Effect Size (Cramér's V)	0.167
Sample Size	307

Figure 27: Chi-squared test results of table 35 – students' computer attitude level and their self-rated ICT ability

My null hypothesis, $H_{0,}$ was the status quo – there was no significant relationship between the student's computer attitude level and their self-rated ICT ability. H_1, the alternative hypothesis assumed that students with a certain computer attitude were likely to rate their own ability in a certain way. For example, a student with a very positive attitude may rate themselves as an intermediate or advanced ICT user. As the P value in my analysis was less than 0.05, the initial null hypothesis was rejected. However, the Effect size (Cramér's V) was close to zero, indicating little association between the variables. In conclusion, there was evidence that there was a significant relationship, with small effect size, between the two variables – the student's computer attitude level and their self-rated ICT ability.

7.1.2.3. Computer attitude and self-teaching

In chapter five, many of the students surveyed responded that they were relying on themselves and were using a digital device such as a laptop, computer, tablet device or mobile phone to assist them become digitally competent. Twenty-one percent of the responses indicated that they were teaching themselves to become digitally competent. My findings are presented in the graph in figure 28 below.

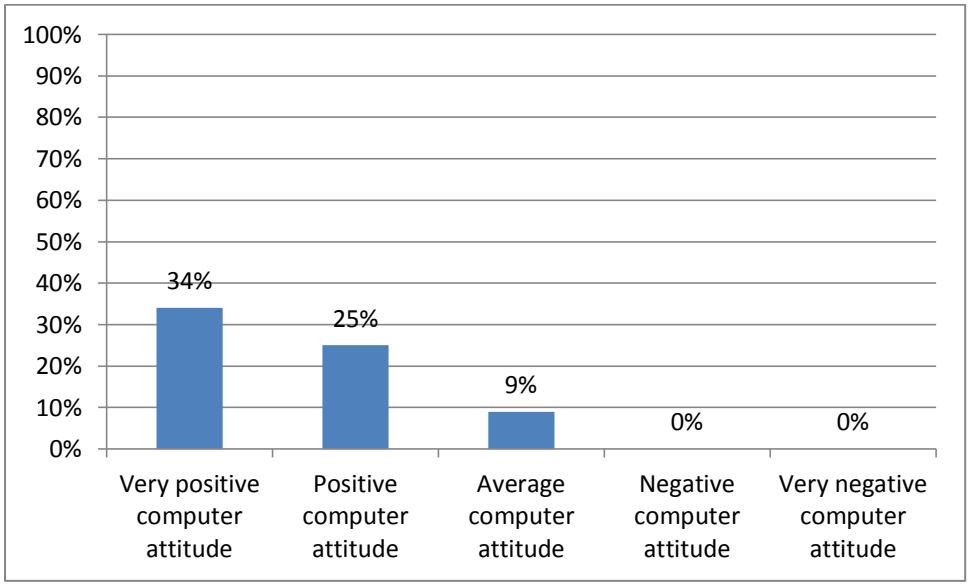


Figure 28: Students' computer attitude level and their self-reliance in developing digital competence

Exploring whether an individual's computer attitude played any role in this independence, I discovered that 34% of the students with **very positive** computer attitudes, 25% of the students with **positive** attitudes and 9% of the students with an **average** attitude mentioned relying on themselves in their responses. A statistical analysis of the data indicated that the students with an **average** attitude who responded that they were relying on themselves revealed a clearly statistically lower value than expected. The two students with **negative** attitudes mentioned using courses and family members to help them. Chi-squared test results revealed a statistically significant relationship, with small effect size, between the two variables, computer attitude and whether the students indicated relying on themselves to develop digital competence. **Very positive** students who indicated that they were relying on themselves resulted in a statistically higher value than expected. As is shown further on in section 7.3, computer attitude and digital self-efficacy are statistically correlated. One would expect a student with a positive computer attitude to have a strong belief in their own ability and thus rely on themselves to help develop their own digital competence.

7.2. Digital self-efficacy

In Bandura's Social Cognitive Theory model, behaviour is determined by environmental influences, such as social pressures, situational characteristics, cognitive and other personal factors. These personal factors may include personality as well as demographic characteristics. Bandura advances two sets of expectations as the major cognitive forces guiding behaviour. The first set of expectations relates to outcomes. It is believed that individuals are more likely to undertake behaviours they believe will result in valued outcomes than those they do not see as having favourable consequences. The second set is relevant to my research. This set encompasses what Bandura calls self-efficacy or beliefs about one's ability to perform a particular behaviour. Self-efficacy influences an individual's choices about which behaviours to undertake. This self-efficacy includes the effort as well as the persistence exerted in the face of obstacles to the performing these behaviours. It ultimately results in the mastery of the behaviours (Compeau & Higgins, 1995).

An individual's digital self-efficacy may be influenced by the barriers that they encounter when accessing ICTs. This reinforces the notion that the phenomena that an individual encounters when using ICTs impact on the final experience of developing digital competence. However, Kay notes that favourable attitudes, as well as a strong belief in one's ability to work with computers, are necessary, but not sufficient to ensure the development of

a computer competent student (Kay, 1993). My research established whether DSE and attitude play significant roles in an individual's development of digital competence.

7.2.1. Measuring digital self-efficacy

Murphy Digital Self-Efficacy Scale (Appendix C)

The Murphy (1989) Digital Self-Efficacy Scale was discussed in detail in section 3.3.2.2. It proved a useful tool to establish the students' levels of DSE. As is appropriate for a five point Likert Scale, the distance between each interval or self-efficacy level is equivalent with an average attitude of a score between 84 to 108 points in the DSE being the midpoint. The intervals are as follows:

Very weak level	32 to 57 points
Weak level	58 to 83 points
Average level	84 to 108 points
Strong level	109 to 134 points
Very strong level	135 to 160 points

7.2.2. Findings from the digital self-efficacy scale

The graph in figure 29 below illustrates the digital self-efficacy levels of the students obtained from their completion of Murphy's digital-efficacy scale in the online questionnaire.

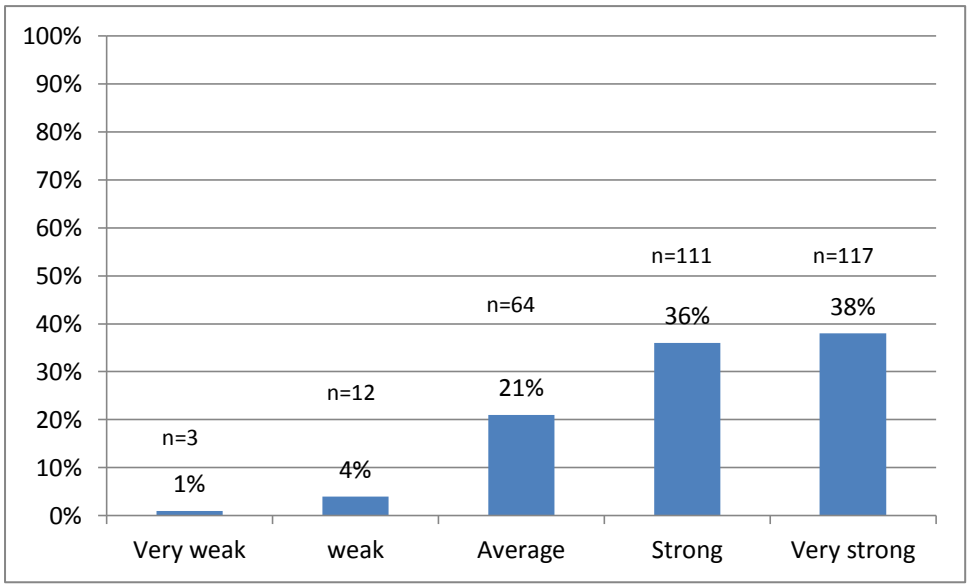


Figure 29: Digital self-efficacy levels of first year pre-service teaching students

All 307 students in the phase two group completed this scale and the statistical analysis of the graph in figure 29 above is provided in figure 30 below.

Descriptive statistical analysis of DSE	
Median	128
Average	125
Confidence Interval of Average	122.07 to 127.50 (± 2.71) on either side of the average
Standard Deviation	24.2
Minimum	45
Maximum	160
Sample Size	307

Figure 30: Descriptive statistical analysis of graph in figure 29 – students' digital self-efficacy levels

The confidence interval was narrow indicating a 95% confidence in the true value of the average. Similar students, that is, any of the other first year pre-service teaching students that did not participate in my research, completing the same assessment, were expected to score within 2.71 lower or higher than the average of 128 with a 95% confidence level and 5% of the students would not. The standard deviation result was slightly larger than that of the computer attitude scores. This indicated that students' scores were not as closely clustered around the average or expected value of the results. There was a wider dispersion of results as the majority of the students scored themselves as having a **strong** to **very strong** digital self-efficacy level.

7.2.2.1. Digital self-efficacy and baseline test result

As is represented in the graph in figure 29 above, 74% of the first year pre-service teaching students had an above average belief in their own ability when it came to using digital devices. Three students had a **very weak** belief in their own ability. Of these three students, one failed the baseline digital competence test and the other two students did not take the test. More specific information relating the students' digital self-efficacy levels and their baseline digital competence test results is presented in table 36 below.

Table 36: First year pre-service teachers' digital self-efficacy levels and test results

Digital self-efficacy level	Pass	Fail	Did not take test	**Total**
Very weak belief	0	1	2	**n=3 (1%)**
Weak belief	3 (21%)	11 (79%)	0	**n=14 (4%)**
Average belief	29 (45%)	34 (52%)	2 (3%)	**n=65 (21%)**
Strong belief	54 (49%)	49 (45%)	6 (6%)	**n=109 (36%)**
Very strong belief	81 (70%)	33 (28%)	2 (2%)	**n=116 (38%)**
Total	**n=167 (57%)**	**n=128 (39%)**	**n=12 (4%)**	**307**

Reading across the rows, the areas highlighted in red indicate where the **majority** of students scored themselves with regards their belief in their own digital ability and whether they passed the baseline test or not. More students with an **average** belief in their own ability failed the test. When discussing the findings of table 36, it is evident that only three students indicated having a **very weak** DSE level. One of these students took the test and failed it. The other two did not take the test. Most of the students with a **weak belief** in their own ability failed the test (79%). 49% of the students with a **strong** belief in their own ability and 70% of the students with a **very strong** DSE level passed the test. Statistical analysis of table 36 above is provided in figure 31 below. The statistics show that there was a statistically significant relationship between the students' digital self-efficacy levels and whether they passed or failed the baseline test. Students who passed the test tended to have higher DSE levels than students who failed the baseline test.

Chi-squared test	
P-Value	0.00001
Effect Size (Cramér's V)	0.301
Sample Size	307

Figure 31: Chi-squared results of table 36 – students' baseline test results and their digital self-efficacy levels

My null hypothesis, $H_{0,}$ was the status quo – there was no correlation between the student's digital self-efficacy level and whether they passed or failed the baseline digital competence test. H_1, the alternative hypothesis assumed that students who passed the test would indicate

having a greater belief in their own digital ability. For example, a student who passed the test may indicate having a strong or very strong digital self-efficacy level, while a student, who failed the test, may indicate having a very weak or weak digital self-efficacy level. As the P value in my analysis was less than 0.05, the initial null hypothesis was rejected. The larger Effect size (Cramér's V) also indicated a certain degree of association between the variables. In conclusion, there was evidence that there was a statistically significant relationship between the student's digital self-efficacy level and their test result.

These findings were similar to the findings in previous table 34 in section 7.1.2.1. presenting the computer attitude levels of the first year pre-service students and their test results. From table 34, it was evident that 47% of the students with a **positive** attitude towards digital devices passed the baseline digital competence test, whilst 50% failed the test. There was a noticeable difference between the students with a **very positive** computer attitude as 63% of these students passed and 32% failed the test. In table 36 above, 49% of the students with a strong belief in their own ability passed the test, whilst 45% failed. The findings show that while a strong belief in your own ability is a possible indicator of future success with digital devices, computer attitude is not. It is possible that having a **positive** attitude towards digital devices has no impact on whether the students will pass or fail the baseline digital competence test. Computer attitude and digital self-efficacy are just two of the many actors interplaying in a student's network of learning to become digitally competent. These findings will be explored further with regards to specific examples of students' networks of learning in chapter eight.

7.2.2.2. Correlation between digital self-efficacy and self-rated ICT ability

Similar to the earlier table 35 which tabulated the computer attitude levels of the first year pre-service teachers and their self-rated ICT ability, table 37 below compares the student's belief in their own abilities and their self-rated ICT ability.

Table 37: Digital self-efficacy levels of first year pre-service teachers and their self-rated ICT ability

Digital self-efficacy level	Novice ICT user	Beginner ICT user	Intermediate ICT user	Advanced ICT user	Blanks	**Total**
Very weak belief	1 (33%)	2 (67%)	0	0	0	**3 (1%)**
Weak belief	2 (14%)	8 (57%)	3 (21%)	0	1 (8%)	**14 (4%)**
Average belief	5 (8%)	38 (58%)	22 (34%)	0	0	**65 (21%)**
Strong belief	11 (10%)	34 (31%)	61 (56%)	3 (3%)	0	**109 (36%)**
Very strong belief	6 (5%)	21 (18%)	71 (61%)	18 (16%)	0	**116 (38%)**
Total	**25 (8%)**	**103 (34%)**	**157 (51%)**	**21 (6%)**	**1 (1%)**	**307**

Reading across the table rows, the areas highlighted in red indicate where the **majority** of students in each digital self-efficacy level scored themselves with regards to their self-rated ICT ability. Three students indicated having a **very weak** belief in their own digital ability. One of these students was a self-rated novice ICT user and the other two were beginner ICT users. Fourteen students had a **weak** belief in their own ability. Most of these with a weak DSE level (57%) rated themselves as beginner ICT users. The majority of the students (58%) who had an **average** belief in their own ability were beginner ICT users. Fifty-six percent of the students with a **strong** DSE were self-rated intermediate ICT users. Sixty-one percent of the students with a **very strong** DSE were also intermediate users.

The majority of self-rated beginner ICT users have a **very weak**, **weak** or **average** DSE level. Intermediate ICT users indicated having a **strong** or **very strong** DSE level. These findings were expected as both the ICT ability levels and the DSE levels are self-rated. Statistical analysis of table 37 above is provided in figure 32 below. The statistics show that there is a statistically significant relationship between the students' digital self-efficacy levels and their self-rated ICT ability.

Chi-squared test	
P-Value	0.00001
Effect Size (Cramér's V)	0.258
Sample Size	307

Figure 32: Chi-squared test results of table 37 – students' digital self-efficacy levels and their self-rated ICT ability

The above analysis investigates any links between a student's digital self-efficacy level and their own self-rated ICT ability. My null hypothesis, $H_{0,}$ was the status quo – there is no correlation between a student's digital self-efficacy level and their self-rated ICT ability. H_1, the alternative hypothesis assumed that there is a correlation between the two. For example, a student indicating they are a novice ICT user may have a very weak belief in their own digital ability, while a self-rated advanced ICT user may indicate a very strong digital self-efficacy level. As the P value in my analysis is less than 0.05, the initial null hypothesis is rejected. There is evidence that there is a significant relationship between the two variables – baseline test result and the student's self-rated ICT ability. Likewise, the Effect size (Cramér's V) is not close to zero, indicating an association between the variables.

7.2.2.3. Digital self-efficacy and self-teaching

As with computer attitude and self-teaching, I looked at the student's belief in their own ability and their response to the question who was helping them become digitally competent. The graph in figure 33 below summarises my findings.

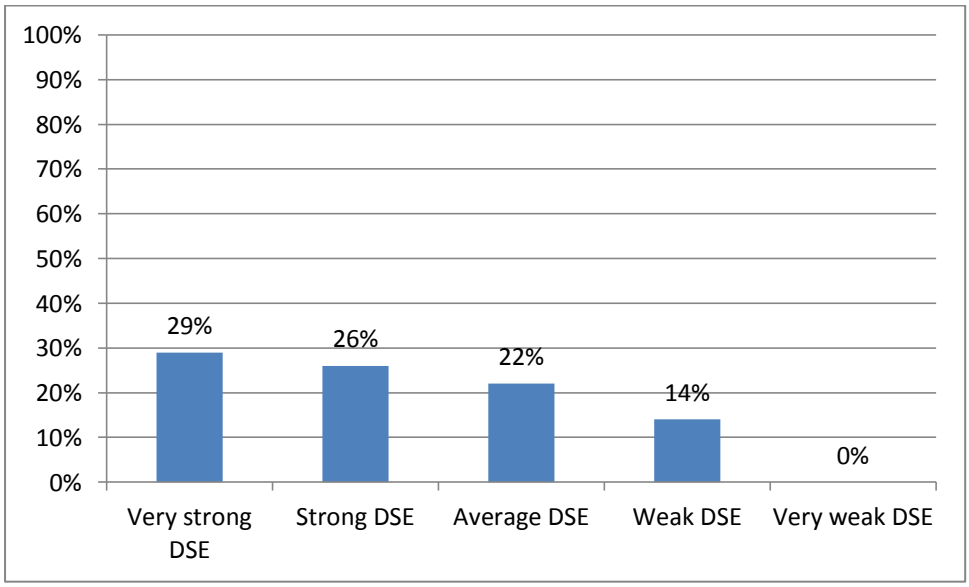


Figure 33: Digital self-efficacy level and their self-reliance in developing digitally competence

I discovered that 29% of the students with **very strong** digital self-efficacy, 26% of the students with **strong** and 22% of the students with an **average** DSE mentioned relying on themselves in their response. Fourteen percent of the students with a **weak** belief in their own ability reported relying on themselves, while the students with a **very weak** DSE mentioned that no one was helping them, but rather they were relying on courses, digital literacy tutors, family and friends. Close to a quarter of each group of students with a **very strong**, **strong** or **average** DSE mentioned relying on themselves. While a statistical analysis of the data revealed no statistical significance between the variables, from my interpretation of the graph in figure 33 above, the results were congruent with my expectation that a student with a strong belief in their own ability would respond that they were relying on themselves.

7.3. Comparing digital self-efficacy and computer attitude scale results

The majority of the first year pre-service teaching students had a **positive** computer attitude and a **very strong** belief in their own digital ability. The graph in figure 34 below illustrates the relationship between computer attitude and digital self-efficacy.

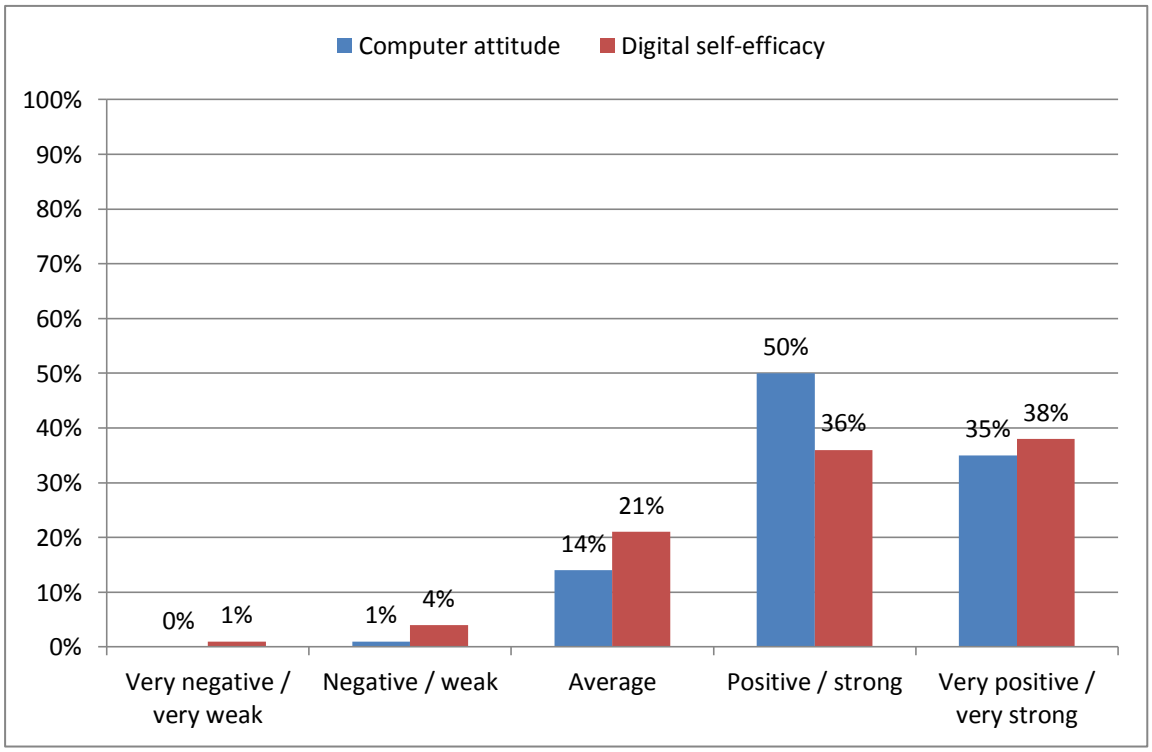


Figure 34: A comparison of computer attitude levels and digital self-efficacy levels of first pre-service teaching students

There are two instances where there was a very close correlation between the two groups of students according to their DSE and computer attitude levels. There was a 3% difference between those students who have a **very positive** computer attitudes and **very strong** levels of digital self-efficacy. There were only a few students in the left lower end of the graph who rated themselves as having a **very negative** computer attitude and a **very weak** belief in their own ability. The difference between these two groups was only 1%. The lower end of possessing a negative attitude and weak self-efficacy level had a close correlation (3%). However, these students at the lower end of the graph only accounted for 6% of the total sample population. Statistical analysis of the graph in figure 34 above is provided in figure 35 below. The statistics showed that computer attitude was positively correlated with digital self-efficacy levels.

Correlation Effect Size	
P-Value	<0.00001
Effect Size (Pearson's r)	0.456
Confidence Interval of Effect Size	0.363 to 0.540
Sample Size	307

Figure 35: Correlation Effect Size test results of the graph comparing students' computer attitude and digital self-efficacy levels

Correlation Effect Size test determines whether or not values for one variable get larger, smaller, or stay the same as values for the other variable get larger. The P-value is the measure of statistical significance. A P-Value, such as the one above, that is less than 0.05 means that a correlation is statistically significant – consistent enough that it unlikely to be a coincidence. The Effect size indicates whether a relationship is meaningful in a practical sense. A negative coefficient indicates that higher values for one variable go with lower variables for the other (instead of higher values). General rules of thumb for correlation effect size interpretation are:

>0.5 large effect

>0.3 medium effect

>0.2 small effect

<0.1 trivial or no effect

The effect size of 0.456 indicated that there was a medium to large effect in the above results. This is better illustrated in the graph in figure 36 below. The computer attitude scores and digital self-efficacy scores were strongly correlated. The two were meaningfully related to

each other as students with positive computer attitudes were likely to have strong beliefs in their own ability. The higher DSE values positively related to the higher CAS values.

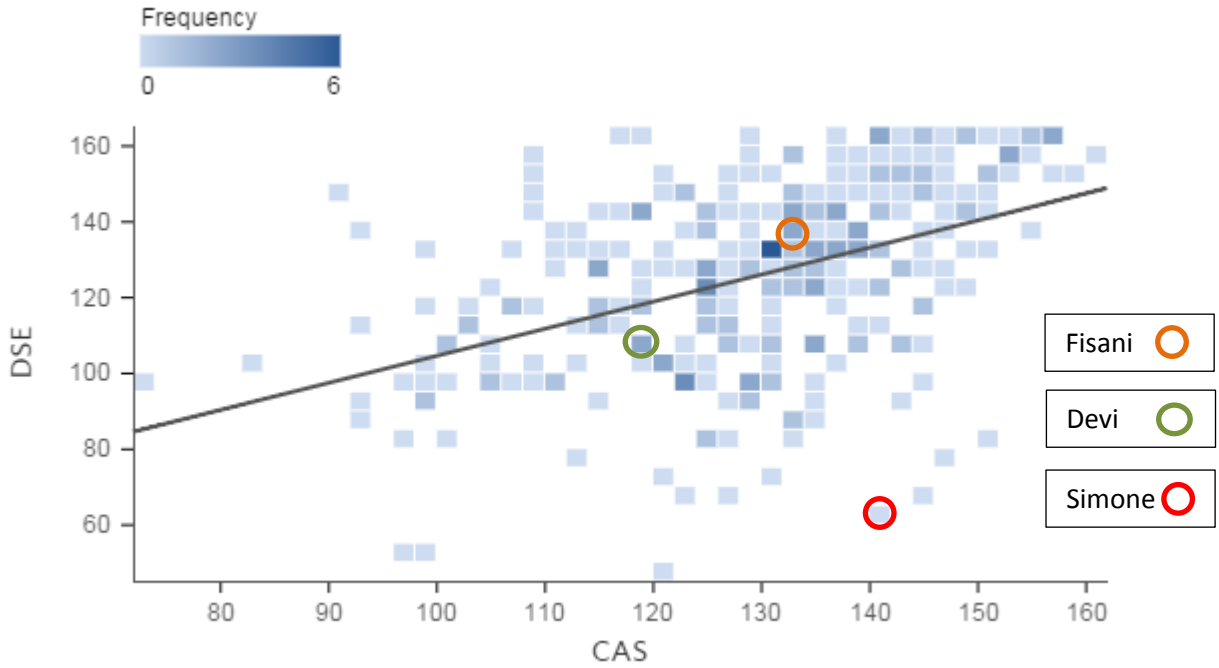


Figure 36: Scatter graph comparison of computer attitude and digital self-efficacy levels of first pre-service teaching students

Further investigation into the relationship between computer attitude and digital self-efficacy revealed that the largest gap between the scores on Loyd and Gressard's computer attitude scale and Murphy's digital self-efficacy scale was 78 points. This student, **Simone**, an 18 year old student, rated her digital self-efficacy at a level of 63 (weak), yet her computer attitude at 141 (very positive). She was positive towards using digital devices, yet did not have a strong belief in her own ability to successfully use them. She failed the baseline competence test and said that she had never used a computer before coming to the HEI. She stated that access was a barrier to her effective use of ICTs as she had never been exposed to them before. She did feel that being next to someone who knew how to use ICT devices would help her become digitally competent.

When examining factors that impact on a student's network of learning to become digitally competent, it is useful to remember that influencing factors, actors or boundary objects are not merely material, they can be "stuff and things, tools, artefacts and techniques, and ideas, stories and memories" (Bowker & Star, 1999, p. 298). Computer attitude and digital self-efficacy are examples of things which are neither contained nor containable by context, but can be enrolled in differing and multiple networks, dependent on the various affordances at

play and the work entailed in naturalising them differently within networks (Fenwick & Edwards, 2010). As discussed in the analytical reasoning chapter four of this thesis, cognition or knowing about something are not static entities owned by individuals or environments. Instead they are distributed acts that exist in the flow of activity and involve individuals interacting in a functional manner over time with other individuals in addition to available social, physical and intellectual resources. Becoming knowledgeably skillful is characterised by an individual's increasing potential to build relations with the material, psychological and social world (Barab, Fajen, Kulikowich, & Young, 1996). The students in my research population interacted with a range of non-human actors without shapes - things without physical entities in the process of coming to be digitally competent. These included "thoughts" and "intentions" such as attitudes and beliefs in own abilities (Fenwick & Edwards, 2010).

Devi is an 18 year old female student. Looking at her unique story illustrates what I am explaining above. She rated herself an intermediate ICT user and passed the test in 2013 with 76%. She had a positive computer attitude score of 120 and a mid-range or average digital self-efficacy score of 104. The difference between her two scores is 14 which is similar to 15% of the total group of students surveyed. It is interesting that she scored herself comparatively quite low to the rest of the students in her belief in her own ability (DSE), yet passed the test well. However, it can be seen in table 36 earlier in section 7.2.2.1., that 49% of the students who passed the test scored themselves within this range. When I interviewed Devi she described her previous experiences with ICTs. She had previously used computers at school and at home before coming to the HEI. She felt comfortable using ICT devices and when she needed to learn something new, she found someone to help her. She did feel that having a positive attitude and belief in her own ability made it easier for her to become digitally literate with her comment of "…*if you know how to use a computer and you know that you know how, then you can use it*." I think this self-awareness is quite important. Metacognition or knowing what you know means that she knew enough about ICTs that she realised what she was capable of and what she did not know. This resulted in an accurate self-rating of her ability.

I assumed that the students who did well in the test would have a positive computer attitude and a strong belief in their own ability. I recognised that having a positive attitude towards computers could still be possible in a student who had not used or had limited access to ICTs

previously. These students could have realised the usefulness of the device and a certain attraction to ICT devices exists in those who do not own them.

Expanding on the notion of actors and nodes in networks of learning as touched on in chapter four and further explored in chapter eight, computer attitude and a belief in one's own ability could each comprise a node. These nodes cannot be seen to be acting in isolation as learning is fundamentally connected with and constitutive of the environmental particulars, including other people, through which it is actualized (Cobb & Yackel, 1996; Lave, 1988). The boundaries among individual cognition and the material and social world become difficult to identify (Barab, et al., 1996). Nodes may provide the basic building blocks of a methodology of learning, yet it is important to note that each component of a node, namely; a participant's understanding, a tool and an object being acted on, forms part of the current activity. Nodes can also made up of previous experiences through which it was developed (Barab, et al., 1996). Although nodes and their components exist in one network, nodes and their components are also constituted by networks. They determine and are determined by the episodes in which they are part (Barab, et al., 1996). If an individual has had a negative experience with ICT devices such as one of the students in my research population. 18 year old Fisani, has a positive attitude towards using ICTs, 133. She failed the test in 2014 with a mark of 52%. Even though she had used a computer before, she described feeling anxious when using digital devices. She was afraid that as she was not yet that competent with ICTs, that she "*might try to do something and then fail to meet the desired end"*. She also had a strong belief in her own ability, 129.

7.4. Motivation to improve digital competence

I was interested in whether the first year pre-service teachers were motivated to improve their current digital competence skills. Forty-two percent of the students surveyed had failed the baseline test so it was evident that improvement was necessary. I questioned whether students with positive computer attitudes and strong beliefs in their own ability would be more or less motivated to improve their skills? I was also interested in their reasons for wanting to better their skills. I included a question in the online questionnaire that asked the phase one students if they wanted to improve their digital literacy levels. The students were given the option of selecting, yes, no and maybe. They were then asked to comment on why they had chosen the answer that they did. As mentioned previously, I used the term *digital literacy* in this question, rather than digital competence, as I felt this would be more relevant

to the student's understanding. For this reason I use the terminology digital literacy in the sections that follow. The students' responses are documented in table 38 below.

Table 38: Phase one students' responses when asked if they wanted to improve their digital literacy levels.

	Yes	**No**	**Maybe**	**Blank**	**Total**
Novice ICT user	22 (88%)	0	2 (8%)	1 (4%)	**n=25**
Beginner ICT user	98 (94%)	1 (1%)	4 (4%)	1 (1%)	**n=104**
Intermediate ICT user	121 (77%)	7 (5%)	29 (18%)	0	**n=157**
Advanced ICT user	13 (62%)	4 (19%)	4 (19%)	0	**n=21**
TOTAL	**n=254 (83%)**	**n=12 (4%)**	**n=39 (12.5%)**	**n=2 (0.5%)**	**307**

I indicated in red the majority of each group of self-rated ICT ability's response to the question. Overall percentages of the students are indicated in the last row. The majority of the students across all ability levels answered that they would like to improve their digital literacy skills. Twenty-two of the 25 novice ICT users indicated that they would like to improve their digital literacy skills. None of the novice students answered no. Even the advanced students want to better their skills. The reasons they provide for this are explored further on in this section. Statistical analysis of table 38 above is provided in figure 37 below. The statistics show that there is a statistically significant relationship between the students wanting to improve their digital skills and their self-rated ICT ability.

Chi-squared test	
P-Value	0.0000285
Effect Size (Cramér's V)	0.224
Sample Size	305 (2 unanswered)

Figure 37: Chi-squared test results of table 38 – students' self-rated ICT ability and whether they wanted to improve their digital competence

My null hypothesis, $H_{0,}$ was the status quo – there was no correlation between a student's self-rated ICT ability and their desire to improve their digital competence skills. H_1, the alternative hypothesis assumed that there was a correlation between the two. As the P value in my analysis was less than 0.05, the initial null hypothesis was rejected. There was

evidence that there was a significant relationship between the two variables – self-rated ICT ability and wanting to improve one's digital skills. Likewise, the Effect size (Cramér's V) was not close to zero, indicating an association between the variables. I decided to further analyse this data with regards the students who failed and passed the baseline digital competence test. The results are represented in table 39 below.

Table 39: Phase one students' responses when asked if they wanted to improve their digital literacy levels and their baseline test result

	Yes	**No**	**Maybe**	**Blank**	**Total**
Failed baseline digital literacy test	119 (93%)	3 (2%)	4 (3%)	2 (2%)	**n=128**
Passed baseline digital literacy test	124 (75%)	9 (5%)	34 (20%)	0	**n=167**
Did not take the test	11 (92%)	0	1(8%)	0	**n=12**
TOTAL	**n=254 (83%)**	**n=12 (4%)**	**n=39 (12.5%)**	**n=2 (0.5%)**	**307**

Highlighted in red are the majority of each group (pass, fail and did not take the test) of students' answer to the question. A Chi-squared test performed on the above data showed that there was a statistically significant relationship with small effect size between the student's baseline test result and whether they wanted to improve their digital literacy levels or not. These findings are provided in figure 38 below.

Chi-squared test	
P-Value	0.000156
Effect Size (Cramér's V)	0.192
Sample Size	305 (2 unanswered)

Figure 38: Chi-squared test results of table 39 – students' baseline test result and whether they wanted to improve their digital competence

My null hypothesis, $H_{0,}$ was the status quo – there was no correlation between a student's baseline test result and their desire to improve their digital competence skills. H_1, the alternative hypothesis assumed that there was a correlation between the two. As the P value in my analysis was less than 0.05, the initial null hypothesis was rejected. There was evidence that there was a significant relationship between the two variables – the baseline test results and wanting to improve one's digital skills. Likewise, the Effect size was not close to

zero, indicating an association between the variables. As with the previous tables, I indicated the percentages of each group, not of the whole phase one student group. Ninety-three percent of the students who failed the baseline test indicated that they were interested in improving their digital literacy skills. None of them indicated no. This would be an obvious result as on receiving the test result they would know that their digital literacy level was not up to the required standard. Very few of the students overall, just 4%, indicated that they were not interested in improving their skills. Their reasons for this, as well as the students who answered maybe, were intriguing and are explored in more detail in the table below and the discussion that follows.

When I asked the students why they wanted to or did not want to improve their digital literacy skills, there were many unique responses as would be expected. I identified a few key trends or categories that I could use to code the data. Within each category there were some subtleties that I would expect as these are individuals with different backgrounds, experiences, personalities, emotions. I identified the following codes to use for the coding of the data for this question of why do you or do you not want to improve your digital literacy skills. I discuss each of these categories below table 40 and provide examples of the students' responses.

Table 40: Coding for responses to why students answered yes, no or maybe for wanting to improve their digital literacy levels

Code	Reason	Explanation
Adv T	Advancing technology	The technological world is rapidly advancing and students need to be prepared to keep up with it
L Kn	Limited knowledge	Not having enough skills or experience to do what they want on ICT devices. Students realising they are not digitally literate
E L	Easier life	Realisation that a certain degree of digital literacy will help with their studies and future teaching career
NB	Important resource	Identifying ICTs and digital literacy as an important resource in their daily lives
D t L	Desire to learn	Stating that they want to improve their skills regardless of their test result as they have a desire to improve and learn
H the Kn	Have the knowledge already	Not necessary to improve their skills as they are already digitally literate or possess enough skills
Unsure	Unsure	Not sure if they need to improve their digital literacy skills or not
TB	Too busy	Too busy to improve their digital literacy skills
UN	Uninterested / unnecessary	Stating that they feel it is unnecessary to improve their digital skills or they are not interested in doing so
LAZ	People lazy	Skills should not be improved as people are lazy and just "google everything"

Fifteen percent of the students stated that they needed to improve their digital literacy skills as ICTs are ubiquitous and they felt the need to keep up with a world in which **technology was rapidly advancing**. An 18 year old female wrote that she would like to improve her digital literacy skills *"because technology is always advancing, I would like to keep up."* This ubiquitous world of digital devices prompted students to respond that they needed to improve their skills or they would not cope in such a world; *"this is a very technological era and if you are not able to use it, you will have a serious problem of getting anything done"* (18 year old female). This realisation of the need to be digitally literate was a strong motivator among the first year pre-service teaching group with a 19 year old student summing it up with her comment that she wanted to become more digitally literate *"because I realise the importance of being digitally literate because digital equipment is becoming more advanced and we have become more dependent on it."* Even advanced students commented on the rapidly advancing world of technology with a 20 year old female responding that she answered yes, *"because although I am an advanced digital user, you can never know too much about digital literacy as it changes every day."*

Forty-two percent of the students surveyed realised that they had **limited knowledge and skills** when it came to using ICT devices. The majority of the students (48%) who answered yes to the question of whether they wanted to improve their digital literacy skills listed their limited knowledge as the reason for their desire for improvement. There may be many reasons for this, which were not asked for or provided in this question. The students detailing the barriers that they face when accessing ICTs would further inform such responses. Thirty-two, (25%) of the students who said that they had limited digital literacy knowledge also listed lack of experience as a barrier to their effective use of ICTs. These barriers are explored in more detail in table 28. Some students realised that their digital literacy skills were lacking when they received the result for their baseline digital literacy test, *"I just wrote an ICT endorsement test which is an indication to me that I need extra help in order to become computer literate"* (17 year old female student). The following comment made by an 18 year old female reiterated the above, *"I really need to improve my knowledge about using computers, because I finished the ICT test having a very painful headache due to what I was struggling to answer, and it was said that these were mere basics."* Confidence levels were also mentioned, *"…because I feel that I am not yet confident enough and do not know enough about certain technology especially programmes like Microsoft Excel"* (18 year old female). A 40 year old male mentioned technophobia as resulting in his limited digital literacy skills.

He said that *"the reason is that I have been having this void and phobia in me whenever I come across anything computerized. I have also missed a lot of job opportunities by not being computer literate."* He was a student who failed the baseline test, had a positive computer attitude (133/160) and a strong belief in his own digital efficacy (120/160).

"I believe that being able to use a computer will make life much more easier for me at university level, since it is the mostly used device for information and to type assignment" was a comment made by a 17 year female who wanted to improve her digital literacy skills as she feels that it will make her **life easier**. Students mentioned that being digital literate made their personal, social and academic lives easier. Mention was also made of how their future teaching careers would also be easier; *"I want to learn more about the digital world so that I can improve myself as a teacher"* (19 year old female) and *"I think digital literacy is important for any student and I want to be able to use a computer as a teacher, it will be very useful and helpful"* (18 year old female). It was also stated that the HEI they were studying at required the students to type assignments before submitting them. Being digitally competent and able to type assignments and search for relevant information on the Internet made their lives easier; *"I answered yes because I believe that once I am computer literate or advance, it will make my transition to university more easier as most of work done in university is typed, printed and then handed in"* (20 year old female). The above comment was confirmed by a 21 year old male who stated that *"university study requires a lot of computer usage. We are from time to time requested to type our assignments, so if I do not improve, this means that I am going to struggle a lot."*

Overall, seven students (2%) made comments about being digital literate as an **important resource** in the world and their lives. Two comments included; *"it is an important resource to have in the 21st century, the digital age"* (18 year old male), and *"I think it is important to understand and how to use a computer"* (19 year old female). I decided to keep these seven responses as their own category as they specifically mentioned that it was an important resource to have in one's life, and not that they needed to be digitally literate and not that their need was as a result of advancing technology as above.

A **desire to learn** and improve one's own abilities was detailed by 8% of the students with comments such as; *"I am always ready to learn new things and perfect old ones"* (18 year old female) and *"The sky is the limit… I can't limit my potential"* (20 year old male). These students wanted to learn more and did not specifically refer to just improving their digital

literacy skills, they just enjoy learning, *"I love improving everything about myself"* (19 year old male) and *"I can never stop learning"* (18 year old female).

The majority of the students (83%, n=10) who answered no to the question of whether they wanted to improve their own digital literacy skills said that they **already possessed the skills and knowledge**. None of the students who answered yes listed this as a reason for their answer. Some did acknowledge that for the moment they felt their skills were sufficient but that this could change in the future; "*I think the knowledge that I have is enough, but I could be wrong"* (19 year old female) and *"I know all I need to know but if the need arises then I would be willing to learn more"* (19 year old male). The students in this category also acknowledged that although they may only know the basics, that it was enough to get them by and they were happy with that. Two students made comments to substantiate this complacent view; *"because I feel that my level of skills are enough to get me by"* (18 year old female) and "*I'm competent enough with a computer in order to complete tasks assigned to me by lecturers"* (20 year old male). I think it was best summed up by a 19 year old female student who said that, *"I feel that if I can type on a computer, use the Internet and understand a little about computer software and hardware, I don't really need to enhance my knowledge on computers".*

Two students stated that they were **unsure** whether they needed to improve their digital literacy skills. Both of these students had passed the digital literacy test, had strong beliefs in their own ability and rated themselves as intermediate ICT users. Both of them answered maybe when asked if they needed to improve their skills and the 18 year old female said that *"I'm not sure how much more I need to know about digital literacy"*.

Another two students stated that they were just **too busy** to improve their digital literacy skills. A further two students said that maybe they would be interested in improving their digital literacy skills, but that it was **unnecessary**. An 18 year old female said that she was *"not a person who is interested in computers. I am comfortable with the basics."* The other student, a 21 year old female, said that she was *"not entirely dependent on the use of digital literacy. Besides university, I use it more often than not as a pastime."* Both of these students had passed the baseline digital literacy test.

"I think the world is becoming a little bit too 'technological' and people are becoming lazy and not using their own intelligence to figure things out, they'd rather just google things"

was a unique and interesting response made by a 19 year old female student who had passed the baseline digital literacy test. She said that she did not feel that she needed to improved her digital literacy skills and listed herself as an intermediate ICT user.

There were some responses that I was unable to code as they did not answer the question. Three students just answered 'yes' and some put their actual baseline digital literacy score as their reasoning for why they did or did not want to improve their digital literacy skills. Table 41 below provides the exact percentages of the coded responses discussed above.

Table 41: Students' responses when asked to clarify on why they wanted or did not want to improve their digital literacy levels

	Yes	**No**	**Maybe**	**Blank**	**TOTAL**
Advancing technology	43 (17%)		1 (2.5%)	1 (50%)	**45 (15%)**
Limited knowledge	123 (48%)		5 (14%)	1 (50%)	**129 (42%)**
Easier life	49 (19%)		1 (2.5%)		**50 (16%)**
Important resource	6 (3%)		1 (2.5%)		**7 (2%)**
Desire to learn	20 (8%)		6 (15%)		**26 (8%)**
Have the knowledge already		10 (83%)	16 (41%)		**26 (8%)**
Unnecessary / uninterested			2 (5%)		**2 (1%)**
Too busy			2 (5%)		**2 (1%)**
Unsure			2 (5%)		**2 (1%)**
People lazy		1 (8.5%)			**1 (0.5%)**
Undecipherable answers	11 (4%)		1 (2.5%)		**12 (4%)**
Blank	2 (1%)	1 (8.5%)	2 (5%)		**5 (1.5%)**
TOTAL	**254 (83%)**	**12 (4%)**	**39 (13%)**	**2 (0.6%)**	**307**

As with the previous tables, I indicated the percentages of each group, not of the whole phase one student group. I highlighted in red the reason the majority of each group, those that answered yes, no or maybe, gave to wanting to improve their digital literacy levels. Forty-

eight percent of the students that answered yes, indicated that this was due to their current limited knowledge. The majority of both the students who answered no (83%) and maybe (41%) did not feel the need to improve their skills as they already possessed the knowledge or necessary skills. These students felt that there was no need to improve their skills as they were already sufficient. A Chi-squared test performed on the above data showed that there was a strong statistically significant relationship between the students wanting to improve their digital literacy skills and the reason they gave for this. The majority of the students who indicated that they wanted to improve their skills said that this was due to their limited knowledge. These findings are provided in figure 39 below.

Chi-squared test	
P-Value	0.00001
Effect Size (Cramér's V)	0.658
Sample Size	300 (7 unanswered)

Figure 39: Chi-squared test results of table 41 – students' desire to improve their digital competence and stated reasons.

My null hypothesis, $H_{0,}$ was the status quo – there was no correlation between a student's desire to improve their digital competence skills and their reason for this. H_1, the alternative hypothesis assumed that there was a correlation between the two. As the P value in my analysis was less than 0.05, the initial null hypothesis is rejected. There was evidence that there was a significantly strong relationship between the two variables. Likewise, the Effect size was not close to zero, indicating an association between the variables. As mentioned above, the students' reason for wanting to improve their digital literacy level was related to the reason they gave for this. The majority of the students who stated that they wanted to improve their skills indicated that their current skills were lacking. The students who stated that they did not or maybe wanted to improve their skills indicated that their current knowledge and skills were sufficient.

7.4.1. Correlation between an individual's computer attitude and digital self-efficacy level and their desire to improve their digital competence

I then used the students' responses in the online questionnaire to investigate whether students with a strong belief in their own ability and positive computer attitude were more inclined to want to improve their digital competence skills in table 42 below.

Table 42: Relationship between a student's computer attitude and their desire to improve their digital competence

Computer attitude level	Yes	No	Maybe	Blank	TOTAL
Very negative attitude	0	0	0	0	**0**
Negative attitude	1 (50%)	1 (50%)	0	0	**2 (1%)**
Average attitude	31 (72%)	3 (7%)	9 (21%)	0	**43 (14%)**
Positive attitude	129 (83%)	5 (3%)	20 (13%)	1 (1%)	**155 (50%)**
Very positive attitude	93 (87%)	3 (3%)	10 (9%)	1 (1%)	**107 (35%)**
TOTAL	**254**	**12**	**39**	**2**	**307**

As with the previous tables, I indicated the percentages of each group, not of the whole phase one student group. The majority of each group (highlighted in red) indicated that they wanted to improve their digital skills. A Chi-squared test performed on the above data showed that there was a statistically significant relationship with small effect size between the students' computer attitudes and wanting to improve their digital skills. These findings are provided in figure 40 below.

Chi-squared test	
P-Value	0.00964
Effect Size (Cramér's V)	0.166
Sample Size	305 (2 unanswered)

Figure 40: Chi-squared test results of table 42 – relationship between a student's computer attitude and their desire to improve their digital competence

My null hypothesis, $H_{0,}$ was the status quo – there was no correlation between a student's computer attitude level and their desire to improve their digital skills. H_1, the alternative hypothesis assumed that there was a correlation between the two. As the P value in my analysis was less than 0.05, the initial null hypothesis was rejected. There was evidence that there is a subtle relationship between the two variables.

Table 43: Relationship between a student's digital self-efficacy level and their desire to improve their digital competence

Digital self-efficacy level	Yes	No	Maybe	Blank	TOTAL
Very weak belief	3 (100%)	0	0	0	**3 (1%)**
Weak belief	13 (93%)	0	0	1 (7%)	**14 (4%)**
Average belief	58 (89%)	2 (3%)	5 (8%)	0	**65 (21%)**
Strong belief	91 (83%)	1 (1%)	16 (15%)	1 (1%)	**109 (36%)**
Very strong belief	89 (77%)	9 (8%)	18 (15%)	0	**116 (38%)**
TOTAL	**254**	**12**	**39**	**2**	**307**

Table 43 above is set out in the same manner as table 42. The percentages of each group, not of the whole student group are indicated and the majority of every group of students who indicated that they wanted to improve their skills is highlighted in red. The students with a very strong belief in their own digital ability indicated that they wanted to improve their digital skills. They understood their own limitations and knew their own knowledge. A Chi-squared test performed on the above data showed that there was no statistically significant relationship between the student's belief in their own abilities and wanting to improve their digital skills. These findings are provided in figure 41 below.

Chi-squared test	
P-Value	0.100
Effect Size (Cramér's V)	0.148
Sample Size	305 (2 unanswered)

Figure 41: Chi-squared test results of table 43 – relationship between a student's digital self-efficacy level and their desire to improve their digital competence

My null hypothesis, $H_{0,}$ was the status quo – there was no correlation between a student's digital self-efficacy level and wanting to improve their digital skills. H_1, the alternative hypothesis assumed that there was a correlation between the two. As the P value in my analysis was more than 0.05, the initial null hypothesis was accepted. There was evidence that there was a no relationship between the two variables. Likewise, the Effect size was close to zero, indicating little association between the variables.

A student's computer attitude played little significance in them wanting to improve their digital competence skills. Regardless of their attitude level, the majority of the students answered that they would be interested in improving their skills. Similarly the majority of the students also answered yes to this question regardless of their belief in their own ability.

7.5. Concluding remarks

In this chapter I investigated the computer attitude levels and digital self-efficacy levels of the first year pre-service teaching students. The majority of the students had a **positive** attitude and an **average** to **above average** belief in their own ability when using ICT devices. When exploring the relation of this positive attitude and DSE on their baseline digital competence test results, it was evident that the majority of students who failed the baseline test had a **positive** attitude and the majority who passed the test had a **very positive** computer attitude. As explored in chapter two, the literature review section of my thesis, having a positive attitude towards computers predicts future ICT use. The majority of the students who said that they were novice or beginner ICT users had a **positive** attitude whilst the self-declared intermediate and advanced ICT users had a **very positive** attitude. In answering the question as to w*hat relationship is there (if any) between computer attitude and a student's attainment of digital competence,* it is apparent that overall the students who passed the test had a **very positive** attitude. When exploring this concept further while looking at individual's unique stories of their network of learning, computer attitude was just one of the many issues at hand that comprised many of the nodes or actors making up a student's networks.

The second question addressed in this chapter looked at the *role that a belief in one's own ability to use ICTs (self-efficacy) plays in the development of digital competence.* I found that the majority of the students surveyed had a **strong** or **very strong** belief in their own ability. The majority of the students who passed the test had a **very strong** DSE and the majority of students who failed had an **average** to **strong** DSE. The self-rated novice students had a **weak** DSE, the beginners an **average** DSE, the intermediate ICT users a **very strong** DSE and the advanced users also had a **very strong** DSE. Kay (1993) notes that favourable attitudes, as well as a strong belief in one's ability to work with computers, are necessary, but not sufficient to ensure the development of a computer competent student (Kay, 1993). As with the barriers and enablers identified in the previous chapter, one single node or actor, cannot be deemed to impact exclusively on a student's process of coming to be digitally competent.

Even though a correlation between computer attitude and digital self-efficacy was established, neither were indicators as to whether a student wanted to improve their digital competence levels. The majority of students answered yes when asked if they wanted to improve their digital literacy level regardless of their own ICT rated ability and whether they had passed or failed the baseline test. They were then asked to provide a reason why they did or did not want to improve their skills. Congruent with the barriers identified in chapter six, the majority of the students who answered yes to improving their skills highlighted their lack of knowledge and previous experience as a motivating factor. The students who answered maybe or no to this question pointed out that they already had the knowledge and skills. This correlated with the enablers identified by the students in chapter six.

Having explored the notion of barriers and enablers in the process or activity of coming to be digitally competent, looking specifically at attitude and self-efficacy, in the next chapter I propose a model of skill acquisition to be used in the analysis of data gathered from my research. I also present and magnify the learning network of six students and then dissect the nodes that make up their respective learning network. Each node is broken up and its elementary features examined. Representing experience in terms of nodes and links provides researchers with a means of capturing and visualising multiple time scales and environmental particulars in one analysis. This is useful for researchers who recognise that cognition is distributed across the task, across the individual, as well as, across the physical and social setting (Barab, et al., 1996). A pre-service teaching student in their first year at a HEI is not defined in the exact moment that they pass or fail the ICT competence baseline test. They are defined by all the nodes that constitute the network of learning in which they are situated.

Chapter 8 - Coming to be digitally competent

My final research question is addressed in this chapter. I apply the framework of actor network theory detailed in chapter four by analysing six first year pre-service teaching students' learning networks of coming to be digitally competent.

> ***Research question 4. How do first year pre-service teaching students come to be digitally competent?***

Roth and McGinn (1996) used network theory to examine how learning unfolds within learner-centred classrooms. They investigated student-centred classrooms and the way resources, i.e. any piece of information, objects, tools, student-constructed artifacts or machines, and practices such as skills, understanding and application of concepts influenced a classroom community. They used network theory to portray the diffusion of resources and practices within the context of science classes. Central to their research was the notion of *tracers*. These tracers denote a pre-existing methodological strategy to find the "same activity" across different contexts. Tracers can refer to practices, conceptual understanding and student productions that can be observed and followed over time (Roth & McGinn, 1996).

Presenting a narrative of each student's network of learning in which I relied on the written and, or, spoken words of individuals, I interpreted the qualitative data gained from the one on one interviews. By focusing on the lives of the individuals as told through their own words, I identified common, or differing, issues of access and present possible solutions. I wanted to find common tracers in each student's network of learning. Each student has their own unique story to tell, their own unique network of learning which enabled them to reach a level of desired digital competence. While an identification and awareness of these common nodes or tracers that impacted positively or negatively a student's learning network is advantageous when designing and presenting a course, individual nodes do not have as much "power" to influence the experience as I initially predicted. Rather it is an interaction of these phenomena interplaying in the network. Some may only exist in the short instance that they are analysed, while some may be more permanent. The context of coming to be digitally competent is not simply the container or a situational created experiential space. Rather, it is an entire activity system, integrating the participant, the object of study and the tools into a

unified whole. Activity is not one aspect of learning and learning is not a type of activity, rather, activity is learning and learning is activity (Barab, et al., 1996).

Before investigating the individual students' stories, I elaborate on the notion of skill acquisition relevant to a student's development of digital competence. Actor network theory treats knowing as situated, embodied and distributed. In ANT research, knowing is enactment, brought forth and made visible through circulations and connections among things. An object of knowledge is held together by a network of connections that must be continually performed to make the knowledge visible and alive. Knowing does not simply arise from certain institutionalised practices of education or the cognitive activities of individuals (Fenwick & Edwards, 2010). In this chapter, I illuminate and examine the nodes that circulate and connect in six first year pre-service teaching students' networks of learning in an investigation of how they come to know, i.e., develop digital competence skills.

8.1. Skill acquisition

In section 5.5 I arrived at a definition of digital competence as the set of knowledge and skills required when using ICT devices to perform tasks and communicate for work. Nearly 30 years ago, Berliner stated that the goal of teacher education colleges should be to prepare the novice and assist the advanced beginner to become a competent teacher. Competence should be the goal with teachers pursuing expertise (Berliner, 1988). As presented in table 4 in section 2.5, and again in chapter six when I drew up a digital competence development framework in table 27 in section 6.1., skill acquisition models are useful in explaining how individuals progress from a novice to mastery level. I detailed in chapter five that the students in my research project believe digital competence is both knowledge and a skill. Therefore, in order to develop this skill, an individual passes through various stages of skill acquisition. For this reason, I explored models of skill acquisition. Hindle's Guidelines for Teacher Training and Professional Development in ICT (figure 19 in section 6.1.) is also a developmental model proposing that the pre-service teaching students progress through five stages. Similar to Berliner's goal of competence, the students are expected to graduate in the second level, that of ICT adoption.

Skill acquisition is a specific form of learning. Speelman and Kirsner point out that learning is the representation of information in memory concerning some environmental or cognitive event and refers to an organism storing something about its past in memory. Skill acquisition

refers to a form of prolonged learning about a collection of events. Through many pairings of stimuli with particular responses, an individual can begin to develop knowledge representations of how to respond in certain situations. These representations have some form of privileged status in memory because they can be retrieved more easily and reliably than memories of single events. As a result, skilled behaviours can become routinised and even automatic under certain conditions. The range of behaviours that involve skill acquisition could potentially include all responses that are not innate. These are responses that can be learned and refined with practice and are not restricted to overt or openly observable behaviours (Speelman & Kirsner, 2008).

ANT flows from and extends the developed interpretivist perspective of the world as organised (Tatnall & Gilding, 1999). Interpretivism describes organising as an intersubjective process which constructs reality from the interpretations of the social (Berger & Luckmann, 1996). Understanding the importance of both internal and external relationships is important to understanding why some organisations succeed while others do not (Pyper, 2007). In my research I extend this analysis of internal and external relationships further than those found in an organisation. I look at these relationships within the context of a learning network to identify why certain learning networks are more successful than others. In an ANT approach, learning is not mental calculations or changes in consciousness. Instead, any changes that may be described as learning, such as new ideas, innovations, changes in behaviour and transformation, emerge in various kinds of networks that are entangled with one another. These networks may be messy and incoherent, as well as spread across time and space (Fenwick & Edwards, 2010). Fox analysed learning processes in higher education, and explained that competence or knowledge from an ANT perspective is not a latent attribute of any one element or individual. Rather, it is a property of some actions rather than others as a network becomes enacted into being (Fox, 2008). Fenwick and Edwards go on to say that the interplay of force relations among technology, things and changes in knowledge at every point in an individual's learning network is a struggle and this struggle is learning. All things emerge through their interconnections in networks, where their nature and behaviours are never inherent, but are produced through continuous interactions and negotiations as they work upon one another (Fenwick & Edwards, 2010). In the next section I illustrate how the nodes that circulate and interact with each other in a network of learning are entangled in each other and even arise as a result of other nodes.

8.2. Networks of learning

It is not unreasonable, in our digitally permeated society to think of digital competence as a basic skill needed to function in society (Gilster, 1997), as an essential requirement for life (Bawden, 2008), or even as a survival skill (Eshet-Alkalai, 2004). The concept of digital competence is a multi-faceted moving target. It is interpreted in various ways in policy documents. A thorough understanding of what the first year pre-service teaching students understand the meaning of digital competence and its underlying sub-competences to be, clarifies the existing needs of these students and recognises where action has to be taken to increase competence levels. ANT proposes that each individual's network of learning is made up of various nodes interacting. I propose that these nodes may be positively or negatively charged, that is, they act as a barrier (negative) or an enabler (positive) to the student's experience of coming to be digitally competent. A student's digital knowledge is produced and circulated through minute translations at the most mundane levels of everyday activity. ANT illuminates how knowledge-making occurs through multiple negotiations and performances by positioning research to focus on the mundane practices (Fenwick & Edwards, 2010). In the sections that follow, I present representations of the students' networks of learning, and what may appear to be an amorphous network (without clearly defined shape or form), does in fact consist of replicable patterns (Law, 1991a). These replications can be discussed in terms of the nature of each actant and the manner in which it tends to act. With human actors, their mobilisation can be discussed as a pattern of action which tends to replicate. With non-human actors, there are forms which repeat. These forms are developed through the nature of the actant and its origin (Harrt, 2013). ANT is not a theory that aims to explain why something happens (Law, 2009). I use ANT as a descriptive tool to tell the story of how relations assemble or do not. Through identification of common replicable patterns that result in successful learning and skill acquisition, I can better inform future practice at the HEI.

Translation is the term Callon (1986) used to refer to the process of forming a network. He proposed that this process occurred in four steps. This first step of *problematisation* defines the problem and the set of relevant actors. By defining the problem and the programme for dealing with it, the actors become indispensable. The problem in my research is the development of digital competence. The actors or nodes were made explicit to me by the students in their responses in the online questionnaire and interviews. *Interessement* is the second stage in which primary actors or nodes recruit other nodes to assume roles in the

network. In the third stage of *enrollment*, the roles are defined and the actors or nodes formally accept and take on these roles. The final stage of *mobilisation* sees the primary nodes assume a spokesperson role for the passive network nodes and seek to mobilise them into action. Translation involves negotiations among human actors and representatives of material actants. Negotiations establish common sets of definitions and meanings for understanding the phenomena with which the network is concerned (Latour, 2005). Interactions between nodes is necessary to establish and hold the connections between them. In order to establish connections, nodes have to be displaced and transformed in order to make them fit into the actor-network. The work that is necessary to displace and transform is called translation (Harrt, 2013). The nodes in the students' networks of learning are stagnant. They react to and are created by the various other nodes. I present the identified nodes when telling the students' stories below and make assumptions regarding the connections between them and they manner in which translation occurs.

8.2.1. Students' stories

Table 44 below is an overview of the 28 students interviewed over a two year period in phase two of my research. Demographic information is provided in addition to their test results and their computer attitude and digital self-efficacy scores. I extracted three pairs of students from this group to compare. The criteria for the pairings were that one of the students had passed the baseline test and the other had failed. In addition, they had the same or very close scores to each other in the computer attitude scale and the digital self-efficacy scale. I did not focus on gender, age or race as I found in chapter six that these factors did not impact on the students' interaction with ICTs. Taking these considerations into account I focus on the practices in **Mandy** and **Thandi's** learning networks (highlighted in orange), secondly, **Nkateko** and **Devi's** (highlighted in blue), and finally **Zendzi** and **Margaret's** (highlighted in green).

Table 44: Selection of six students from the 28 students interviewed in phase two

	Research Year	Pseudonym	Age	Gender	Race	Test result	Result	Home Language	Beginner, intermediate or advanced ICT user	CAS score	CAS Level	DSE score	DSE level
1	2014	Aria	18	Female	Indian	pass	74%	English	intermediate	152	very positive	155	very strong
2	2013	Beko	18	Female	African	pass	65%	isiZulu	beginner	130	positive	119	strong
3	2013	Hex	18	Female	White	pass	74%	English	intermediate	115	positive	126	strong
4	2014	Mandy	18	Female	African	fail	54%	Sesotho	beginner	143	very positive	148	very strong
5	2013	Michelle	29	Female	White	pass	90%	English	intermediate	153	positive	159	very strong
6	2014	Dean	18	Male	African	fail	40%	Siswati	intermediate	143	very positive	160	very strong
7	2013	Saul	20	Male	African	pass	62%	Sesotho	intermediate	147	positive	160	very strong
8	2014	Sarah	18	Female	African	fail	50%	Xitsonga	beginner	132	positive	86	average
9	2014	Nkateko	18	Male	African	fail	46%	Xitsonga	intermediate	130	positive	103	average
10	2013	Pumi	18	Female	African	pass	66%, 69%	isiNdebele	intermediate	149	very positive	142	very strong
11	2013	Mina	18	Female	African	pass	81%	English	intermediate	142	very positive	152	very strong
12	2013	Nona	22	Female	African	pass	71%	isiBhaca	beginner	124	positive	124	strong
13	2014	Thandi	18	Female	African	pass	73%	isiZulu	advanced	144	very positive	149	very strong
14	2014	Lee	17	Female	African	fail	48%	English	beginner	124	positive	129	strong
15	2014	Bernatricia	18	Female	African	fail	43%	Xitsonga	intermediate	126	positive	152	very strong
16	2013	Angel	19	Female	African	fail	42%, 62%	isiXhosa	beginner	140	very positive	160	very strong
17	2014	Nosheen	18	Female	Indian	pass	70%	English	intermediate	126	positive	146	very strong
18	2013	Margaret	19	Female	White	pass	74%	Afrikaans	advanced	124	positive	136	very strong
19	2013	Khomo	18	Female	African	pass	70%	Sepedi	advanced	146	very positive	144	very strong
20	2014	Maym	18	Female	Indian	pass	88%	English	beginner	100	average	107	average
21	2013	Peter	20	Male	African	pass	66%	Sesotho	beginner	114	positive	117	strong
22	2014	Zanzi	18	Female	African	pass	58%	isiZulu	intermediate	117	positive	160	very strong
23	2014	Dennis	17	Male	African	fail	41%	isiZulu	beginner	144	very positive	67	weak
24	2014	Fisani	18	Female	African	fail	52%	isiZulu	intermediate	133	positive	133	strong
25	2013	Devi	18	Female	Indian	pass	76%	English	intermediate	120	positive	104	average
26	2013	Ann	19	Female	Indian	pass	76%	English	intermediate	155	positive	156	very strong
27	2014	Rocky	18	Female	White	pass	86%	English	advanced	141	very positive	160	very strong
28	2013	Zendzi	40	Female	African	fail	42%, 62%	isiXhosa	beginner	130	positive	131	strong

Fourteen students were interviewed in 2013 and 2014. Of these 28 students, 10 stated that their home language was English. Five spoke isiZulu, three Sesotho, two isiXhosa and three spoke Xitsonga. The rest of the group was made up of one speaker of each of the following languages: Siswati, isiNdebele, isiBhaca, Sepedi, and Afrikaans. Of this phase two research population, five of the students were males and the remaining 23 were females. The youngest student was 17 and the oldest was 40 years old. The majority of these students indicated that they were intermediate ICT users. There were 10 beginners, and only four advanced users. Ten of the students had failed the baseline digital competence test. The remaining 18 had passed the test. Even though an individual's race was not seen to be a particularly influential factor when discussing a student's attainment of digital competence, the racial demographics of this specific group of students was that 19 were black Africans, five were Indian and the remaining four were white. As detailed in chapter three, no coloured students were available for the phase two in-depth interviews conducted. Ten of the phase two students indicated having a very positive computer attitude. The majority (n=17) said they had a positive attitude and one detailed having an average attitude towards computers. Sixteen of the phase two students detailed in table 44 above, had a very strong belief in their own digital self-efficacy. Seven had a strong DSE level, four an average level and one had a weak belief in his own ability.

As mentioned above, my criteria in selecting each pair of students was that one of them had passed the baseline test and the other had failed. They also had the same or similar scores to each other in the computer attitude scale and the digital self-efficacy scale. I chose to compare **Mandy** and **Thandi's** networks of learning as Mandy had failed the test and Thandi had passed it. They both had very similar positive computer attitudes and very strong beliefs in their own digital abilities. I selected **Nkateko** and **Devi** to compare as Devi had passed the test, while Nkateko had failed it. I was interested in these two students as unlike the majority, they indicated having only a positive attitude towards ICTs and an average belief in their own DSE. Similar to Mandy and Thandi, they were both 18 years old. The difference between these two couples was that Nkateko was male and Devi was female. I had not initially intended to focus on this as a criterion for selection as my research had shown that gender was not a determining factor or barrier in the effective use of ICTs. However, the literature had highlighted this factor and I was interested to see how it played out in an analysis of a student's network of learning. Finally **Zendzi** and **Margaret** were two students who unlike the previous four students only had positive computer attitudes and strong beliefs in their

DSE levels. Zendzi, aged 40 years old, was the oldest student to participate in my research. She had initially failed the test while the younger Margaret had passed the test.

The primary ANT method is ethnographic – based on interviews with actors (Latour, 2005). I used the interviews conducted with the six identified phase two students to describe their backgrounds. I identified commonalities in their qualitative responses to the interview questions as they described the process they have gone through in their quest to become digitally competent. Through this method of 'unpacking' and highlighting of the nodes that made up the networks of learning, I not only made visible what each network contained but also what was not there. The things themselves and the ways in which these things are laid out, formulate the space as well as the knowledge that emerges in the different spaces through which an individual moves. The individual is continually solving mundane everyday problems and working with the action directed by the things as well as the problems they pose. The solutions to these problems are the ongoing generation of knowledge that is so often missed in studies of learning (Fenwick & Edwards, 2010). Through an investigation into each student's response I provide an account of the manner in which these students come to be digitally competent. As mentioned in section 3.4.2., my research findings may be 'relatable' to the rest of the first year pre-service teaching students at the HEI under investigation and possibly similar students at other higher education institutions. These conclusions will assist course developers in their planning and execution of digital competence courses in future.

8.2.1.1. Mandy and Thandi

Both Mandy and Thandi were 18 year old first year pre-service teaching students interviewed in 2014. Mandy failed the test with a score of 54% and Thandi passed the test with a score of 73%. Mandy rated herself as a beginner ICT user and Thandi rated herself as an advanced user. Interestingly both had a very similar computer attitude rating, with Mandy scoring herself 143 and Thandi scoring herself 144. Both of these students had very positive attitudes towards ICTs. Again, both students had very strong beliefs in their own digital abilities with Mandy rating herself as having a DSE score of 148 and Thandi, 149. Both of these students' home language was an African language and English was their second language. They both would have liked to improve their digital competence skills. Mandy because: "*I want to be up to date with what we as teenagers usually do*" and Thandi because "*I would like to know more*." Both of these students were the initiators of their desire to improve their digital

competence skills. Both believed that their previous experience with ICTs enabled them to effectively use ICTs. In the online questionnaire Mandy felt that her slow typing skills hampered her effective use of ICTs. In her interview, she also detailed software programmes such as Microsoft Powerpoint and Excel making it difficult for her. Thandi did not provide an answer for what she felt were barriers to her effective use of ICTs. When I asked her this question in the interview, she stated that "*it is not hard*", indicating that she experienced no barriers.

Even though both of these students had used ICTs before, their previous experience with and primary use of them was quite different. Mandy had recently acquired a laptop at home which she used to receive emails and had been taught the basics at school. Thandi used a computer almost every day. She used it for typing any school assignments as well as for social networking. Mandy was not teaching anyone else to use ICTs, while Thandi was teaching her friends and her sisters at home.

As Thandi had passed the baseline test, she was not required to attend the first year course lectures. Mandy, on the other hand had failed the test and was required to attend the lectures which she found useful. At times Mandy felt that computers could sometimes make her feel stupid because she wouldn't know where to press. On the other hand, she felt that it did make her life easier as there was a lot of "stuff" that could be done on a computer. Thandi enjoyed using ICTs as she felt good when using them and never got tired of using them. Even though Mandy wanted to improve her digital competence skills, she felt as though she was forced by her more digitally competent peers to continuously improve her skills. Thandi said that she was "*not forced by anyone. I love computers and enjoy using them*." When asked how she had come to be digitally competent, Mandy explained that she just "*played around*." I explore the significance of such a statement in section 8.3. She elaborated that "*you just have to test some other things, get exposed to them because in these days people use technology more rather than using old stuff.*" Thandi said that she "*learnt at school through my teacher and also taught myself as I grew older.*"

I explored the nodes that came into play in each student's network of learning. As explained in sections 4.3.1 and 4.3.3, the terms actor, actant and node have been used interchangeably in ANT research. I use the encompassing term **node** from this point forward. Each node in the network is made up of five categories, namely the participant (purple), the initiator (green), the issue at hand (red), the practice (blue) and the resource (orange). I simplified

each node by only presenting what the emphasised or key category feature of that node is within Mandy's learning experience. As can be seen in figure 42 below of one node in Mandy's learning network, I focused on the category of the participant. This is an individual involved in a node, but not initiating the action. This may be the student herself, in this case, Mandy, as well as her peers and course presenters. While I highlight my focus on the participant component of this node, I remain aware of and do not negate the other four components, the initiator, the issue at hand, the resource and the practice. For this reason, I still include these categories as smaller components of the node in the figures that follow. Barab's category descriptions, including the applications to my research was provided in table 12 in section 4.3.3.



Figure 42: An actor or node in Mandy's learning network

In table 45 below, I document the components that made up the nodes constituting both Mandy and Thandi's networks of learning. As I have shown in table 12, and in more detail in figure 10 in section 4.3.3., each node or actor is made up of five components; an issue at hand, an initiator, the practice, a participant and the resources. As I looked for commonalities between these two students' experiences of coming to be digitally competent, I found there were only a few which I highlighted in grey below.

Table 45: Node components of Mandy and Thandi's networks of learning

Node components (detailed in chapter four)	**Mandy**	**Thandi**
Issues at hand	Very positive computer attitude Very strong belief in own digital self-efficacy Enabler – experience Barrier – typing skills Barrier – software programmes	Very positive computer attitude Very strong belief in own digital self-efficacy Enabler – experience Barrier - none
Initiators	Self Female 18 year old African Home language: Sesotho More digitally competent peers	Self Female 18 year old African Home language: isiZulu
Practices	Failed test Beginner ICT user Attends the lectures Not first time use Emails Doesn't teach anyone	Passed test Advanced ICT user Not attending lectures Not first time user Assignments and social networking Teaches her peers and sisters
Participants	Self Digital devices Digital literacy tutor (as she attends the lectures)	Self Digital devices Peers
Resources	Self Peers Previous experience Course material Digitally competent other Computer	Self Peers Previous experience

Mandy and Thandis' networks of learning were different. Even the components making up each node within their unique networks of learning differed. While these two students were the same age, same race, same gender, had the same attitude towards ICTs as well as the same belief in their own ability, their networks of learning were unique to them and their previous and current experience. The assumption that students with a high computer attitude and, or high level of digital self-efficacy were more likely to pass the baseline digital competence test is negated in the above example. While both Mandy and Thandi had the

same scores in the CA and DSE scales, they differed vastly in their test results. However, of the six students I compared, they were the only two students who experienced the same enabler of experience to their ICT usage. While this was a common node in both their learning networks, it was not a predictor of success. Mandy and Thandi reported relying on themselves, their peers and their previous experience in their development of digital competence. However, the less successful Mandy made mention of accessing more resources than Thandi. Mandy also made use of course materials such as the course notes, a computer and digitally competent others. It would appear that access to multiple varied resource nodes within a learning network is not a guarantee of success. However, each primary node in the learning network itself is a black-boxed network and depunctualisation within it may have occurred. For example, Mandy explained that she relied on herself as a resource in her development of digital competence. This primary node of ***self*** is a punctualised network that has become black-boxed. The process of punctualisation converts an entire network into a single point or actor into another network (Callon, 1991). Superficially zooming in on the node and opening the black box to explore it in more detail, one realises that this primary node is made up of a network of the secondary nodes of a female, Sesotho speaking, 18 year old, beginner ICT user, who has a very positive computer attitude and very strong belief in her own digital ability. The secondary nodes of weak typing skills and difficult software programmes also feature in the network that makes up the primary node of self. As nodes are shaped by being part of a set of relations and have the power to change each other (Harrt, 2013), it is possible that one of secondary nodes within the network that constitutes the primary node of self may have resulted in the node of ***self*** negatively impacting on her network of learning. Mandy's reliance on herself as a resource in developing digital competence may have impacted on her failure of the test. These are mere assumptions. The network of secondary nodes within the primary node of ***failed the test***, is one that interests me most. Why are so many of the first year pre-service teaching students less successful than others? This question drives the discussion in 8.3.

Figure 43 below, presents a diagram of Mandy's expanded network of learning.

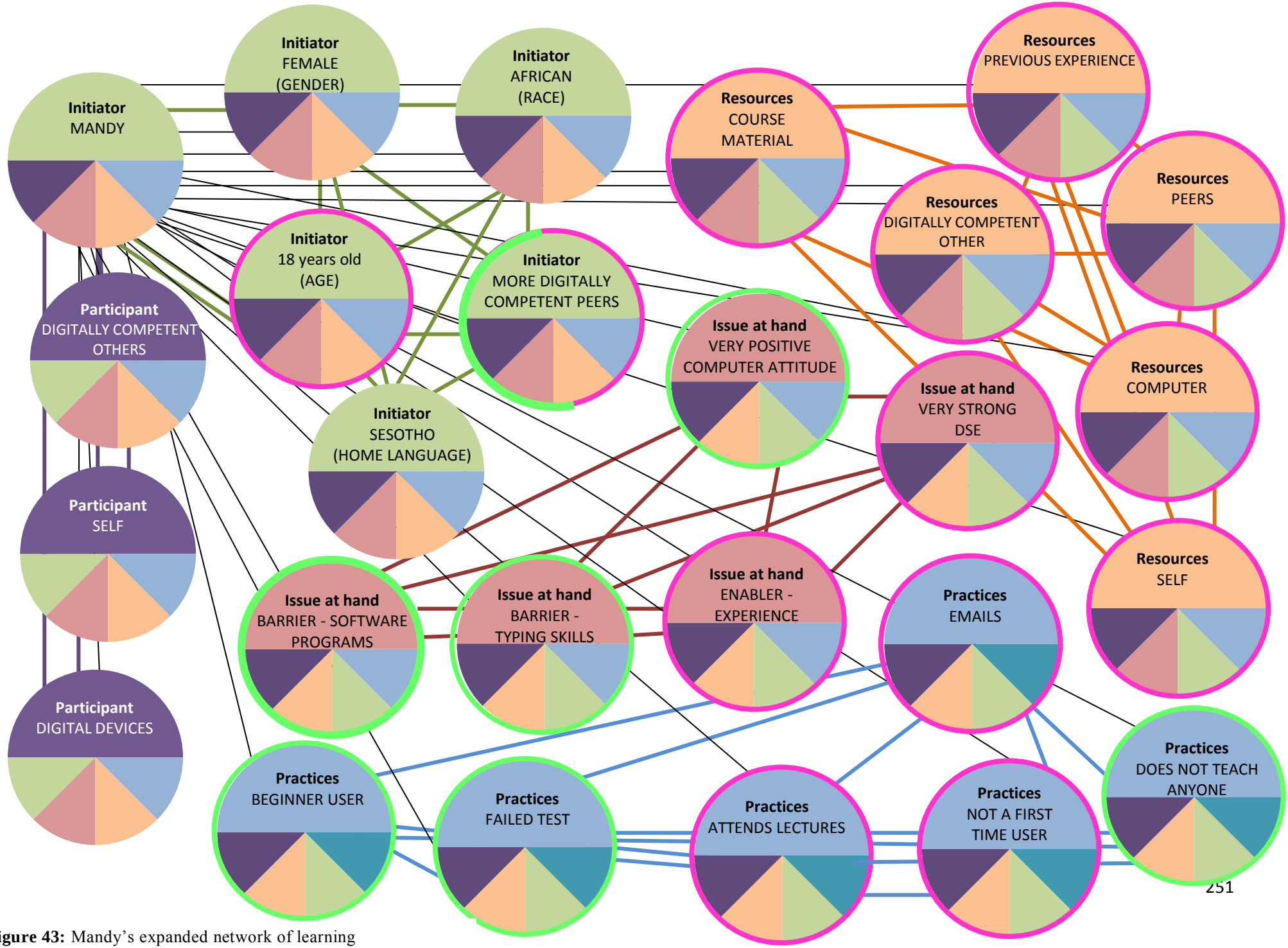


Figure 43: Mandy's expanded network of learning

How does one approach a story such as Mandy? She is a young first year-pre-service teaching students enrolled at a HEI. She failed the baseline digital competence test. Why? Because she is a beginner ICT user? This would be an easy way to explain what happened. However, I wanted to take it further. I wanted to unpack exactly what was going on in Mandy's network of learning in the instant that I was privy to examining it.

Assuming an ANT approach, all individuals, such as Mandy are not agentic and intentional. Mandy is an effect of a particular network of associations. The things that become part of this actor-network are effects produced by particular interactions with one another (Fenwick & Edwards, 2010). Human and non-human nodes came together and connect, changing one another to form links. Entities that connect eventually form a chain or network of action and things, and these networks become stable and durable. At each of these connections, one entity works upon another to *translate* or change it to become part of a collective or network of coordinated things and actions. ANT's unique contribution is to focus on the individual nodes holding networks together, examine how these connections come about and what sustains them. These include negotiations, forces, resistances and exclusions, which are at play in these micro-interactions that eventually forge links. I do this by unpacking the nodes that make up Mandy's network of learning. ANT accepts nothing as given, including humanity, the social, subjectivity, mind, the local, structures and other categories common in educational analyses. As a result, unitary objects with properties are better understood as assemblages, built of heterogeneous human and non-human things, connected and mobilised to act together through a great deal of ongoing work. Translation is a process which generates ordering effects such as devices, agents, institutions, or organisations (Law, 1992).

An ANT approach offers the potential for re-thinking taken for granted ideas. One could assume Mandy failed the test because she was a beginner ICT user. In this section I demonstrate that there are many complex nodes that come into play within her network of learning and each node is complicated in its makeup of various categories. However, ANT cannot be reduced to a catch-all theory that can be universally applied (Cressman, 2009). Below, I present **my** interpretation and analysis of Mandy's network of learning applying my understanding of ANT.

In figure 43 above I present Mandy's network of learning to become digitally competent by identifying key nodes described to me in her interview and through an analysis of her answers in the online questionnaire. An **initiator** is an individual that when engaged in a

practice produces an action. Mandy is the key initiator in her network of learning. I positioned this node with the initiator category highlighted in the top left corner of the diagram. This is the student herself and she is linked to all the nodes within her network. For this reason, linkage lines are drawn to all the other nodes I identified in her learning network. The other four nodes in which the initiator category is highlighted define Mandy. She is a female, African, Sesotho speaking, 18 years old and she indicated in her interview that she was forced to improve her digital competence by her more digitally competent peers. I linked these initiator nodes to each other with thick, dark green lines. The **resource** nodes that Mandy relied on in her network of learning were the course material, digitally competent others, for example, a lecturer or course presenter. She also used herself, her laptop and her peers to help her. The resource nodes are linked to each other with a thick orange line. **Participants** are any individuals involved in a network but who do not initiate the action. The three participants I identified in Mandy's network of learning are herself, her peers and the digitally competent others, such as digital literacy course tutors, who were helping her become more digitally competent. These nodes are linked to each other by thick purple lines. Even though Mandy was an initiator of this network, she was also a participant as she indicated that she was relying on herself to develop her own digital competence. The **practices** or interactions with other nodes that the initiator, Mandy, carried out using the available resources included emailing, attending lectures, taking and failing the baseline test, being a beginner ICT user and at that moment not teaching anyone else how to use ICTs. Even though Mandy rated herself as a beginner ICT user, her first year at the HEI was not her first time using digital devices. These practices are linked to each other by a thick blue line. The component of the nodes that I was most interested in was the **issue at hand**. Two nodes represent the barriers that Mandy indicated as negatively impacting on her engagement with ICTs. These were software programmes and her weak typing skills. The enablers that Mandy experienced were her previous experience and I suggest her very positive computer attitude and very strong digital self-efficacy level. The issues at hand are linked to each other by a dark brown line.

In figure 43 above, I ringed the positively charged nodes – those which I felt impacted positively on Mandy's learning experience, in pink. The negatively charged nodes are highlighted in green. There was one which could be either negative or positive – the initiator of more digitally competent peers. Mandy felt that she was forced to keep up with her peers which drove her desire to become digitally competent, yet she wanted to be part of this more

digitally competent peer group – "*we as teenagers*". I left the neutral nodes un-highlighted. These were the demographics of the initiator, namely, Mandy's race, gender, age and home language. It could be argued that Mandy was a digital native and this may have counted in her favour as she began the process of becoming digitally competent. However, as discussed in section 1.7., Czerniewicz and her colleagues have shown, that especially in the South African context, age is not a defining factor, rather the issue of access is. Overall, Mandy's network of learning was positively charged.

While my research showed in chapter seven that computer attitude had little impact or no impact on a student's success rate in the baseline digital competence test, I still considered an individual's computer attitude as an important issue at hand to consider when unpacking the nodes that make up their network of learning. However, Mandy disagreed with me. She said that a positive computer attitude was a disadvantage "*because you then think you know something whereas you do not. At some point you just have to take a step back, like – you know nothing*". As a result, I indicated that she felt her positive attitude may have had a negative impact on her learning network, hence the green circle. I had not considered this viewpoint prior to this interview. My statistical findings in chapter seven where I investigated the relationship between computer attitude and baseline test success were now contextualised. The literature indicated that computer attitude does impact on the development of digital competence, yet here is an example of an individual stating that it does not. This statement shows the uniqueness of each student's original practical experience. All the other students answered this question similarly to later discussed, Devi, who said that a positive computer attitude made it easier to become digitally competent because "*if you know how to use a computer and you know that you know how, then you can use it*".

In an ANT analysis human and non-human nodes are treated in the same way. Their performances and linkages are focused on rather than distinguishing them according to some a priori (pre-determined) essentialised features. An understanding of a node being a network and vice versa is essential. As I unpacked Mandy's learning network I searched for interesting links between the nodes. A node can create another node, or even be created by another node. It could exist for the brief instance that another node is linked to it. A network of learning is fluid, unstable and in the brief instance that I was privy to the inner workings of Mandy's network, I captured it and translated it onto paper. It would have changed within

the next instant. It will not be the same now as it was when I translated it. Other nodes have come into play, even my interviewing of her may have triggered some meta-cognition and me, myself may have become a node in her learning network in the instant that we connected. As Fenwick and Edwards point out, this is one of the hardest things to keep hold of and operationalise, especially when the weight of history and culture is so great towards privileging human intention and agency, putting us at the centre of things rather than being part of them (Fenwick & Edwards, 2010). Two of the issues at hand that Mandy identified were the two barriers of software programmes and her weak typing skills. These two nodes link to her practice node of being a beginner ICT user. The practice of attending lectures is linked to the fact that she was a beginner ICT user (practice) and failed the baseline test (practice). While the initiators of her learning network were more digitally competent others that she felt the need to keep up with, these individuals were also identified as resources and participants within her learning network. She relied on more digitally competent others and her peers to help her. While she was a beginner ICT user (practice), she had a very positive computer attitude (issue at hand) and a very strong belief in her own ability (issue at hand). Mandy had a very strong DSE, yet she still failed the test. Even though she indicated she was a beginner ICT user, she was still relying on herself to become more digitally competent.

Delving even deeper into the notion of an ANT analyses, there are things that circulate through a network and perform particular functions. In some early ANT analyses, these things were referred to as tokens and mediators. Examples of tokens are the paintbrushes in art classroom or a sign directing visitors to reception. Tokens are intermediaries helping the network to translate entities to perform particular roles. A mediator, on the other hand, also circulates through the network but can transform, distort and modify the meaning in the elements. A particular pedagogical practice, a mobile phone, an achievement award or anything that creates possibilities and occurrences for connections can be a mediator. Latour notes that there are endless numbers of mediators at work in any network and that each can become complex, leading in multiple directions which will modify the contradictory accounts attributed to its role (Fenwick & Edwards, 2010). Just one of the mediators that I identified in Mandy's network was her baseline test fail mark. As a result of this mediator, Mandy had to attend the first year digital competence course lectures. This impacted on her learning network and development of digital competence. However, the strength of this mediator is debatable. A failed baseline test forced Mandy to attend the lectures. However, students who did not attend the course may have developed digital competence in other ways.

The non-human nodes in Mandy's network of learning, such as the available resources played just as an important role as the human, participant nodes in her network of learning. Fifty-six percent of the first year pre-service teaching students surveyed in 2013 and 2014 passed the baseline digital competence test. Mandy was in the minority of the 44% that failed. Like Mandy, the majority (64%) of the students who indicated they were beginner ICT users, also failed the test. Only 35% of the students surveyed indicated having a very positive computer attitude. Mandy was one of these students in addition to one of the 20 (7%) Sesotho students. Mandy was also in the majority (70%) of the students in the 18 to 19 age category. She was an example of one of the minority of the students who failed the test, yet had a very positive computer attitude (32%). Only 21% of the self-rated beginner students had a very positive computer attitude. Similar to 94% of the other beginner students and 93% of the students who failed the baseline test, Mandy wanted to improve her digital competence skills. In line with 17% of the students surveyed, she indicated that this was due to advancing technology. The majority of the students with very positive computer attitudes also indicated wanting to improve their digital skills (87%). Mandy indicated relying on herself with the majority of the other students surveyed (21%) as well as a digitally competent other (8%). Concentrating on the issue at hand component of the nodes, Mandy was only one of the 9 students who indicated in the online questionnaire that her weak typing skills were a barrier to her effective use of ICTs. As with the majority of the students (32%) she found that her previous experience was an enabler to her interaction with digital devices. When asked to provide a definition of digital literacy, Mandy also indicated that it was a functional skill aligning herself with the majority of the surveyed students (69%). A statistically significant relationship between the variables of baseline test result and a student's digital self-efficacy level was established in chapter seven. Mandy is one of the majority of students (38%) with a very strong digital self-efficacy level. However, statistical results provided in table 36 in 7.2.2.1. show that students with a higher DSE are more likely to have passed the baseline test, not fail it. Mandy was only one of the 33 students (28%) with a very strong DSE who failed the baseline test. Only 18% of the self-rated beginner students had a very strong DSE level. Mandy fell in the majority of the students with very strong DSE levels who indicated they wanted to improve their digital competence skills (77%).

Is Mandy's unique story an example of an unsuccessful learning network of coming to be digitally competent? While Mandy may be characteristic of the majority of the students surveyed in certain areas, depunctualisation occurred – Mandy failed the test. The fact that

the course organisers relied on one test to judge the success or effectiveness of a student's learning network has its own inherent issues, but for the purpose of my research, it is the common factor or practice node that I used to compare the various students. I opened the black box of assumed digital competence and unpacked the various nodes that interplayed on Mandy's network of learning. When trying to decide which node was "at fault" and not allowing for the effective, smooth functioning of the learning network, I discovered that all the interlinked nodes made this difficult. On the whole, Mandy's network was positively charged. Were the four negative nodes; that she had failed the test, was a beginner ICT user and encountered the barriers of weak typing skills and unfriendly software programmes, strong enough to indicate that she would not become digitally competent or develop at a slower rate? No – all this can tell us is that there is more to the story. Could diminishing the effect of these nodes on the other nodes may make learning easier or quicker? Detailing how a student became digitally competent involved more than acknowledging that the student passed the baseline test and received a credit for the course. The student acquired a myriad of skills. When learning something there are countless things that an individual designs, selects, organises, stores, evaluates, maintains and responds to, as well as the humans with whom he or she interacts at every moment. Furthermore, things themselves, embed complex histories of events and forces that produce them and continue to change them. To view things as either the products of human design or as brute tools controlled through human action alone is to underestimate the power and contribution of things themselves in enacting events. It is to overlook the complex effects that these non-human entities produce through associations with other (human and non-human) things (Fenwick & Edwards, 2010).

Above I explored my application and interpretation of ANT to Mandy's network of learning. Below I present Thandi's unique learning network. Comparing Mandy's network of learning to Thandi's in figure 44 below, the commonalities and differences of node components between the two students presented in table 45 become apparent.

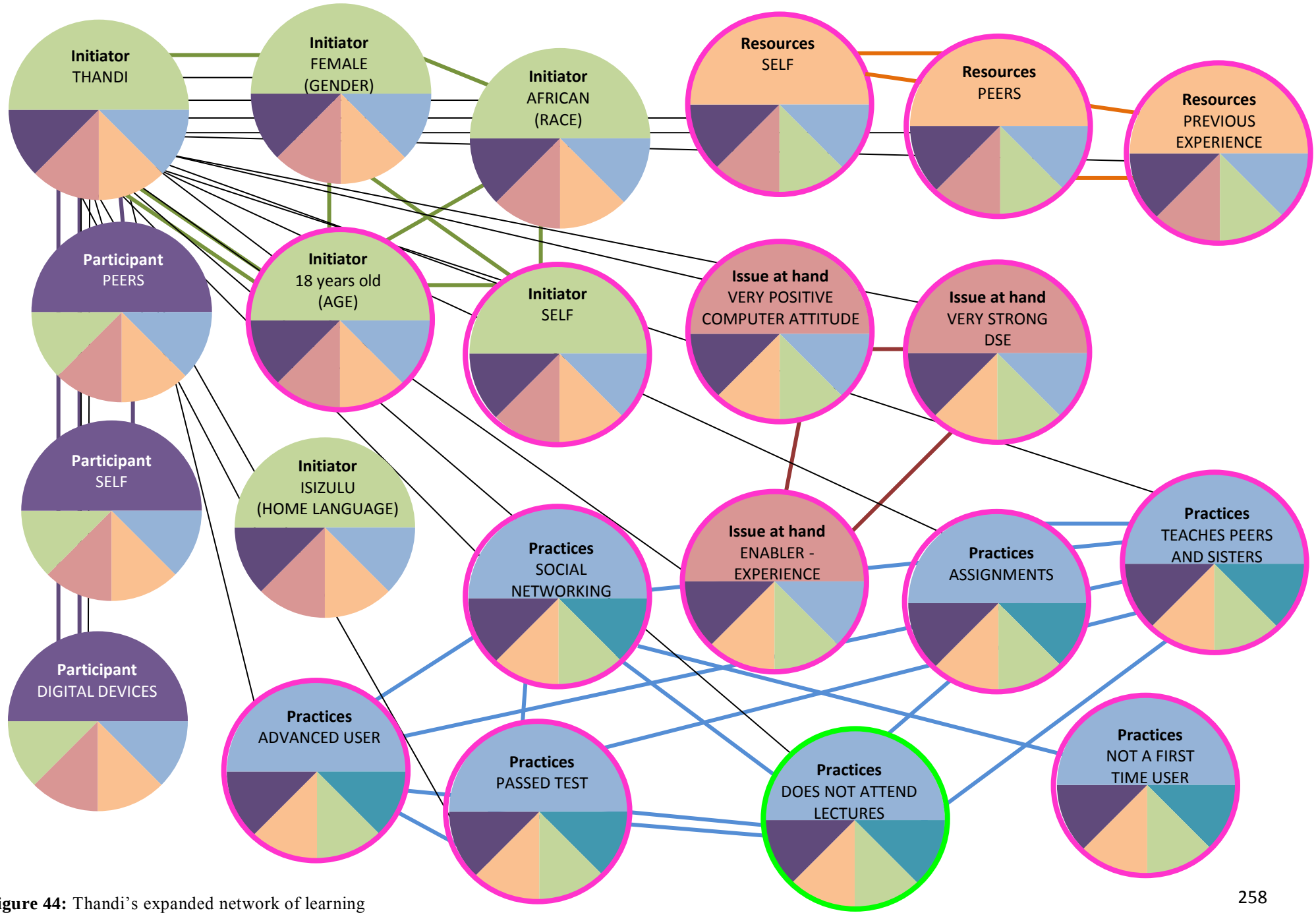


Figure 44: Thandi's expanded network of learning

In figure 44 above I present Thandi's network of learning to become digitally competent by identifying key nodes described to me in her interview and through her answers in the online questionnaire. As with Mandy's network of learning, I highlight the positively and negatively charged nodes and showed linkages with lines. I only identified one negatively charged node that could impact negatively on Thandi's learning network of coming to be digitally competent. Thandi was exempt from attending the first year digital competence course lectures as she had passed the baseline test. The neutral nodes highlighted the initiator component, namely, Thandi's race, gender and age and home language. As with Mandy, it could be argued that Thandi was a digital native and this may have counted in her favour as she began the process of becoming digitally competent. Overall, Thandi's network of learning was positively charged.

Thandi was the key initiator in her network of learning. I positioned this node with the **initiator** category highlighted in the top left corner of the diagram. This is the student herself and she is linked to all the nodes within her network. The other four nodes in which the initiator category is highlighted define Thandi. She is a female, African, isiZulu speaking, 18 years old and she indicated in her interview that she was self-motivated to improve her digital competence. The **resource** nodes that Thandi relied on in her network of learning were her peers and herself. She also mentioned relying on her previous experience with digital devices to help herself. The two **participants** I identified in Thandi's network of learning were herself and her peers. Like Mandy, even though Thandi was an initiator of this network, she was also a participant as she indicated that she was relying on herself to develop her own digital competence. The **practices** or interactions with other nodes that the initiator, Thandi, carried out using the available resources included completing assignments, social networking taking and passing the baseline test, being an advanced ICT user and at that moment teaching her peers and sisters how to use ICTs. Thandi rated herself as an advanced ICT user, her first year at the HEI was not her first time using digital devices. The component of the nodes that I was most interested in was the **issue at hand**. Thandi did not identify any barriers as negatively impacting on her engagement with ICTs. The enablers that Thandi experienced were her previous experience and possibly, her very positive computer attitude and very strong digital self-efficacy level.

Thandi identified the participants in her learning network as herself and her peers. She also identified these two components as resources within her learning network. I highlighted the mediator of the baseline test result in the previous student's Mandy's network. This mediator

was also evident in Thandi's network. However, the role this mediator may have played differed as Thandi had passed the test. As a result, Thandi did not have to attend the first year digital competence course lectures. This may have impacted on her learning network and development of digital competence. While she did not attend the lectures, would her development of digital competence not have been accelerated or enhanced had she attended?

Fifty-six percent of the first year pre-service teaching students surveyed in 2013 and 2014 passed the baseline digital competence test. Thandi was in the majority of those that passed. Like Thandi, the majority (90%) of the students who indicated they were advanced ICT users, also passed the test. Only 35% of the students surveyed indicated having a very positive computer attitude. Thandi was one of these students in addition to one of the 102 (33%) majority isiZulu students. Thandi was also in the majority (70%) of the students in the 18 to 19 age category. She was an example of one of the majority of the students who passed the test and had a very positive computer attitude (63%). Only 13% of the self-rated advanced students had a very positive computer attitude. Similar to 62% of the other advanced students and 75% of the students who passed the baseline test, Thandi wanted to improve her digital competence skills. In line with a few of the students surveyed (8%), she indicated that this was due to her own desire to learn. The majority of the students with very positive computer attitudes also indicated wanting to improve their digital skills (87%). Thandi indicated relying on herself with the majority of the other students surveyed (21%) as well as her peers (15%). Concentrating on the issue at hand component of the nodes, Thandi was only one of the 32 students (10%) who indicated in the online questionnaire that she did not experience any barriers to her effective use of ICTs. As with the majority of the students (32%) she found that her previous experience was an enabler to her interaction with digital devices. When asked to provide a definition of digital literacy, Thandi indicated that it was an information skill aligning herself with the minority of the surveyed students (6%). Thandi was one of the majority of students (38%) with a very strong digital self-efficacy level. Thandi confirmed statistical results provided in table 36 which showed that students with a very strong DSE are more likely to have passed the baseline test (70%). Only 16% of the self-rated advanced students had a very strong DSE level. Thandi fell in the majority of the students with very strong DSE levels who indicated they wanted to improve their digital competence skills (77%).

Thandi may be more characteristic of the majority of the students surveyed than Mandy. Thandi passed the baseline test and one could say that punctualisation occurred. I opened the black box of assumed competent digital competence and unpacked the various nodes that interplayed on Thandi's apparent successful network of learning. One could assume Thandi passed the test because she was an advanced self-rated ICT user whilst Mandy failed because she was a beginner user. However, this was not the first time both of them were using digital devices and both scored themselves as having very positive computer attitudes and very strong beliefs in their own abilities. Comparing Mandy and Thandi's learning networks I saw that the initiator components of the nodes were the same, except for their home languages. The resource component of each node was similar in that they both relied on themselves and peers to help them become digitally competent. The issues at hand components were similar and both students identified their previous experience with ICTs as positively enabling their current ICT usage. Unlike Mandy, Thandi did not experience any barriers. The only similarity in their practices was that neither of them were first time users. The practice component of the nodes making up and interacting in their networks of learning was where I identified the greatest difference. Mandy only used ICTs to send emails and she was not teaching anyone else how to use ICTs. Thandi was using ICTs to complete her assignments, participate in social networking activities and she was teaching her peers and her sisters how to use ICTs. Could their differing practices have led to Thandi being more successful in the baseline test than Mandy? Their positive computer attitudes and strong DSE levels would not appear to have had any impact in a comparison of these two students' networks.

I am reluctant to volunteer an explanation for Mandy and Thandi's differing results. Factors identified in the literature that could impact on a student's development of digital competence were detailed in section 2.3. All my research into applying an ANT approach has shown that learning networks consist of nodes that result from, link to, rely on or conflict with each other. They can be permanent or temporary. In the instant that I investigated Mandy and Thandi's unique learning networks, the nodes described in figures 43 and 44, were the visible human and non-human nodes at that moment of investigation. However, in my initial approach to answering research question four, *how do students develop digital competence*, I searched for commonalities and differences in the two learning networks. I thought that once I had identified these commonalities, I would be able to present a reliable linear path for students to follow and for course presenters to present. A series of development steps that you followed, and if an individual did this and this and that, they would be guaranteed to

become digitally competent. I highlighted these in table 45. This is an area in which I have grown from naïve researcher looking for finite answers to accepting that research can be messy and unpredictable. If pushed to offer a tentative explanation to explain their differing test results, I suggest that the more successful Thandi experienced no barriers and was an advanced ICT user. Whereas, Mandy listed two barriers, (her weak typing skills and software programmes), and was a beginner ICT user. As Brown and Czerniewicz (2010), and Markauskaite (2005), stated, the human factor was a greater determining factor in successful ICT use than age. However, the less successful Mandy, was the student who detailed having access to a digital literacy tutor, as well as, relying on peers and digitally competent other ICT users to help her. Thandi passed the test and mentioned relying only on herself and her peers. When presenting the literature views on digital factors, I highlighted Gudmundsdottir's (2005) statement that access to ICTs does not guarantee success. Rather, skills and opportunities are more important. Both Mandy and Thandi had prior access to and experience with ICTs. Age was not a factor as these two students were both 18 years old. One passed the baseline test and the other failed. However, as Brown and Czerniewicz (2010) point out, age is not a factor and one should not assume that digital natives are digitally competent. There are numerous studies into the barrier that language may play. Both of these student's home languages was not English, yet one passed and the other failed the baseline test. Markauskaite (2005) raised the issue of gender disparity in access and use of ICTs. However, both Mandy and Thandi are females, so will have experienced this factor equally.

I further explore the correlation in my analysis of the next two pairs of students. In analysing my data to answer research question 3b, I found a statistical correlation between a student's digital self-efficacy and their test result. When selecting the pairs of students to compare, I sought out students who had similar computer attitudes and digital self-efficacies, to eliminate these two nodes from my analysis of their learning networks. I show that two students with identical computer attitudes and beliefs in their own ability have very different success rates in the test. I do not negate my statistical findings in chapter seven, but show that a deeper investigation into the nodes that comprise learning networks reveals many more nodes and interconnections at work. Acknowledging the role a belief in one's own ability may play in the development of digital competence, I make recommendations to developing DSE in chapter nine.

8.2.1.2. Devi and Nkateko

Both Devi and Nkateko were 18 year old first year pre-service teaching students interviewed in 2013 and 2014 respectively. Nkateko failed the test with a score of 46% and Devi passed the test with a score of 76%. Both rated themselves as intermediate ICT users. Both have a very similar computer attitude rating, with Devi scoring herself 120 and Nkateko scoring himself 130. Both of these students have a positive attitude towards ICTs. Again, both students only have an average belief in their own digital abilities, scoring themselves 104 and 103 in the DSE scale. They spoke different home languages. Devi spoke English and Nkateko, Xitsonga. They both wanted to improve their digital literacy skills. Devi because: "*I think that by learning more about digital literacy, it will help me as a teacher and in my personal life."* and Nkateko because "*because with my score I realise am left behind, in planet Mars*." Nkateko said he did not know who would help him in the process of coming to be digitally competent. However, he did say that he was using his mobile phone which was with him all the time when asked what he was using to help himself become digitally competent. Devi mentioned her older brother, mobile phone and computer assisting her. Nkateko mentioned himself as an enabler to his ICT usage, while Devi highlighted her previous experience and available support material. In the online questionnaire and his interview Nkateko felt that software language hampered his effective use of ICTs. He spoke about the language used on the computer being different to that used on a mobile phone. He also found that some keys on keyboards were difficult to understand. Devi mentioned the barrier of support material in her response in the online questionnaire elaborating that *"It is difficult to use a digital device when the instruction manual is not very clear or is missing some instructions on how to use the device*". She confirmed this in her interview stating that the technicalities of ICTs hindered her. Both of these students had used ICTs before, and were currently using them for their studies at the HEI. They both mentioned using them for games and Devi also used them for social networking activities. Devi was teaching her younger brother to use ICTs, while Nkateko was teaching his friends and siblings.

As Devi had passed the baseline test, she was not required to attend the first year course lectures. Nkateko, on the other hand had failed the test and was required to attend the lectures. Devi detailed feeling indifferent when asked to describe her feelings when using ICTs. Nkateko described feeling nervous the first time as he did not know if he was doing the correct thing. When asked how she had come to be digitally competent, Devi explained that she had relied on others to teach her. Nkateko said that he "*got a wake-up call*" when he

received his baseline test result. He understood that there were skills that needed to be built on – "*I know I can type, but there are certain things that contribute to my typing before I can type. So I had to understand how it came around for me to be able to type*."

In table 46 below, I document the components that make up the nodes constituting both Devi and Nkateko's networks of learning. I highlighted in grey the commonalities between these two students' experiences of coming to be digitally competent.

Table 46: Node components of Devi and Nkateko's networks of learning

Node components	Devi	Nkateko
Issues at hand	Positive computer attitude Average belief in own digital self-efficacy Enabler – support material Enabler – experience Barrier – support material	Positive computer attitude Average belief in own digital self-efficacy Enabler – self Enabler - access Barrier – software language
Initiators	Self Female 18year old Indian Home language: English	Self Male 18 year old African Home language: Xistonga
Practices	Passed test Intermediate ICT user Not attending lectures Not first time use Assignments Games Social networking Teaches younger brother	Failed test Intermediate ICT user Attending lectures Not first time user Assignments Games Teaches friends Teaches siblings
Participants	Self Digital devices Family Digital competent others	Self Digital devices Digitally literate tutors as attends lectures
Resources	Family Course material Digitally competent others Computer Mobile phone Previous experience	Self Mobile phone

As with Mandy and Thandi, Devi and Nkatekos' networks of learning were different. Each of the nodes within their unique network was comprised of different elements. While these two students were the same age and had the similar positive attitude towards ICTs as well as the same average belief in their own ability, they differed in gender and race. As predicted,

their networks of learning were unique to them and their previous and current experience. They differed in their test results showing that computer attitude and digital self-efficacy level were not indicators of success in the baseline test. Devi had access to more resources and passed the test. Nkateko only had himself and his mobile phone to rely on, and he failed the test.

Below are diagrams of Devi and Nkateko's networks of learning. As with the previous figures detailing the students' learning networks, I simplified each node by only presenting key feature of each node.

In figure 45 below I present Devi's network of learning to become digitally competent by identifying key nodes as she described to me in her interview and through her answers in the online questionnaire. Overall, Devi's network of learning was positively charged. I identified two negatively charged nodes that could impact negatively on Devi's learning network of coming to be digitally competent. Devi was not attending the first year digital competence course lectures as she had passed the baseline test and she identified unavailable support material, such as instruction manuals as a barrier to her effective engagement with ICTs. As with the previous two students, due to her age, it could be argued that Devi was also a digital native.

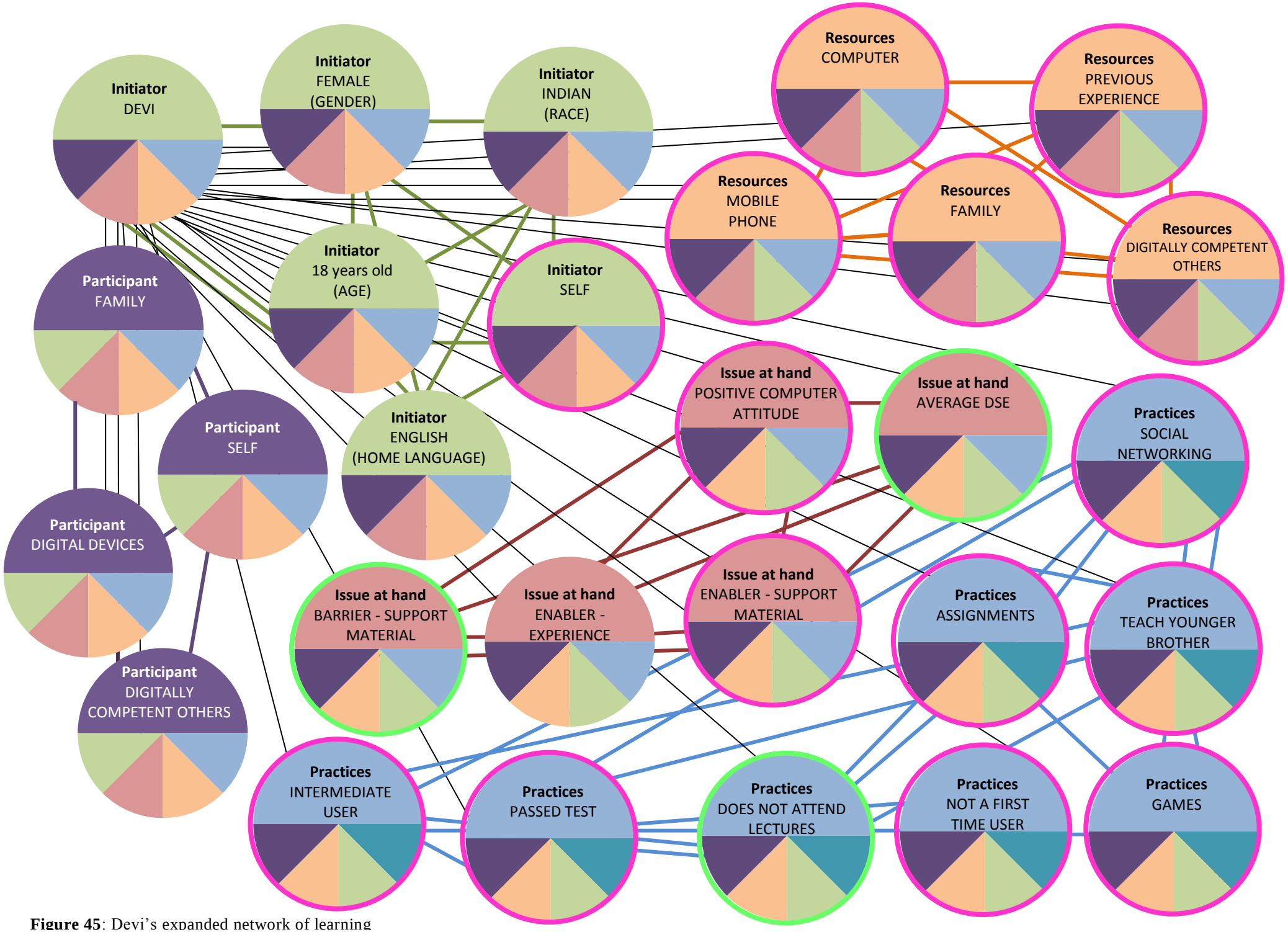


Figure 45: Devi's expanded network of learning

Devi was the key **initiator** in her network of learning. The other four nodes in which the initiator category is highlighted define Devi. She is a female, Indian, English speaking, 18 years old and she indicated in her interview that she was self-motivated to improve her digital competence, acknowledging her limited knowledge. The **resource** nodes that Devi relied on in her network of learning were her family, digitally competent others, computers and her mobile phone, in addition to her previous experience. The **participants** I identified in Devi's network of learning were herself, her family and digitally competent others. As with the previous students, even though Devi was an initiator of this network, she was also a participant as she indicated that she was relying on others to help her. The **practices** or interactions with other nodes that the initiator, Devi, carried out using the available resources included completing assignments, social networking, playing games, taking and passing the baseline test, being an intermediate ICT user and at that moment teaching her younger brother how to use ICTs. Devi rated herself as an intermediate ICT user and her first year at the HEI was not her first time using digital devices. The component of the nodes that I was most interested in was the **issue at hand**. Devi identified the barrier of lack of access to suitable support material as negatively impacting on her engagement with ICTs. The two enablers that Devi experienced were access to relevant support material and her previous experience. She identified support material being both a barrier and an enabler. Devi's positive computer attitude and average digital self-efficacy level were lower than the previous two students. Devi identified the participants in her learning network as herself, digitally competent others and her family. The mediator I focused on the previous students' networks was the baseline test result. Devi had passed the test. As a result, she did not have to attend the first year digital competence course lectures. Once again I ask if she had attended, would her learning may have been positively enhanced?

Devi was in the majority of those that passed the baseline test. Like Devi, the majority (74%) of the students who indicated they were intermediate ICT users, passed the test. The majority (50%) of the students surveyed indicated having a positive computer attitude. Devi was one of these students in addition to one of the 68 (22%) minority English speaking students. Devi was also in the majority (70%) of the students in the 18 to 19 age category. She was an example of one of the minority of the students who passed the test and had a positive computer attitude (47%). The majority of the self-rated intermediate students had a positive computer attitude (46%). Similar to 77% of the other intermediate students and 75% of the students who passed the baseline test, Devi wanted to improve her digital competence skills.

In line with a few of the students surveyed (19%), she indicated that this was due to possessing a degree of digital competence making her life easier. The majority of the students with positive computer attitudes also indicated wanting to improve their digital skills (83%). Devi indicated relying on family with the minority of the other students surveyed (15%), her mobile phone (17%) and in line with the majority of students, a computer (54%). Concentrating on the issue at hand component of the nodes, Devi was only one of the four students (1%) who indicated in the online questionnaire that she experienced a lack of suitable support material such as instruction manuals as a barrier to her effective use of ICTs. As with the majority of the students (32%) she found that her previous experience was an enabler to her interaction with digital devices. Like 13%, she added that access to and availability of suitable support material (10%) also enabled her ICT usage. When asked to provide a definition of digital literacy, Devi indicated that it was a functional skill aligning herself with the majority of the surveyed students (69%). Devi was one of the minority of students (21%) with an average digital self-efficacy level. Having passed the baseline test, Devi contradicted the statistical results provided in table 36 in 7.2.2.1., that students with an average DSE were more likely to have failed the baseline test. Only 34% of the self-rated intermediate students had an average DSE level. Devi fell in the majority of the students with average DSE levels who indicated they wanted to improve their digital competence skills (89%).

In figure 46 below, I detail Nkateko's expanded network of learning. As with the previous three students, it could be argued that Nkateko was a digital native, yet he still failed the baseline test. Overall, Nkateko's network of learning was positively charged. I identified two negatively charged nodes that could impact negatively on Nkateko's learning network of coming to be digitally competent. Nkateko failed the baseline test and identified software language as a barrier to his effective engagement with ICTs.

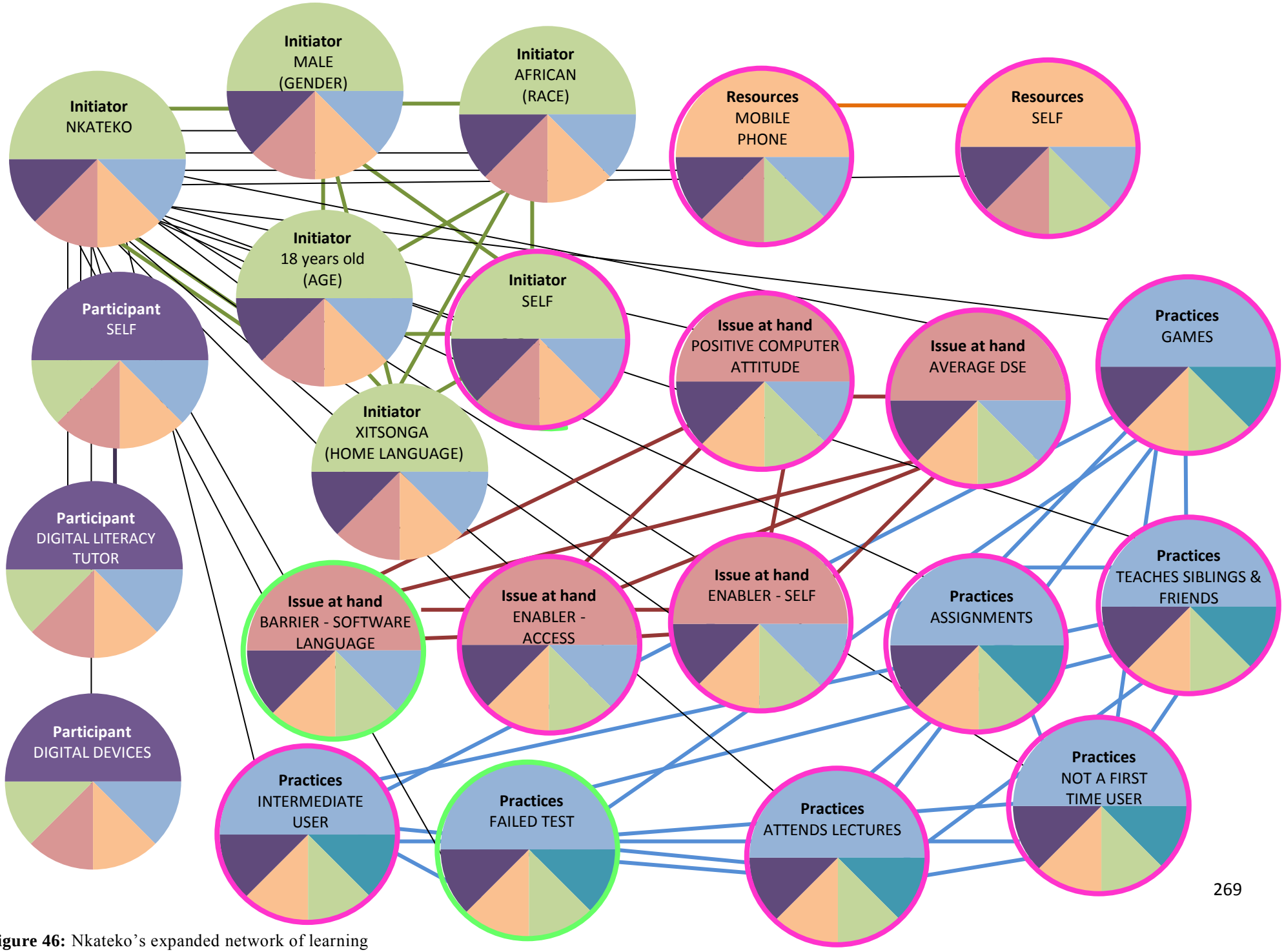


Figure 46: Nkateko's expanded network of learning

Nkateko was the key initiator in his network of learning. I positioned this node with the initiator category highlighted in the top left corner of the diagram. This is the student himself and he is linked to all the nodes within his network. The other four nodes in which the initiator category is highlighted define Nkateko. He is a male, African, Xistonga speaking, 18 years old and he indicated in his interview that he was self-motivated to improve his digital competence, acknowledging his limited knowledge and skills. The **resource** nodes that Nkateko relied on in his network of learning were himself and his access to his mobile phone. The **participant** I identified in Nkateko's network of learning was himself. He did not know who else would help him develop his digital competence. The **practices** or interactions with other nodes that the initiator, Nkateko, carried out using the available resources included completing assignments, playing games, failing the baseline test, being an intermediate ICT user and at that moment teaching his friends and siblings how to use ICTs. Nkateko rated himself as an intermediate ICT user and his first year at the HEI was not his first time using digital devices. The component of the nodes that I was most interested in is the **issue at hand**. Nkateko identified the barrier of computer terminology or software language as negatively impacting on his engagement with ICTs. The enablers that Nkateko experienced were himself and his access to his mobile phone. Unlike the first two students analysed, both Devi and Nkateko only had a positive computer attitude and an average digital self-efficacy level. The mediator I focused on the previous students' networks is the baseline test result. Nkateko failed the test. As a result, he had to attend the first year digital competence course lectures.

Nkateko was in the minority of the students that failed the baseline test. Only 24% of the students who indicated they were intermediate ICT users, failed the test. The majority (50%) of the students surveyed indicated having a positive computer attitude. Nkateko was one of these students in addition to being one of the ten (3%) Xitsonga speaking students. Nkateko was also in the majority (70%) of the students in the 18 to 19 age category. He was an example of one of the majority of the students who failed the test and had a positive computer attitude (50%). He was in the majority of the 46% of the self-rated intermediate students who had a positive computer attitude. Similar to 77% of the other intermediate students and 93% of the students who failed the baseline test, Nkateko wanted to improve his digital competence skills. In line with the majority of the students surveyed (48%), he indicated that this was due to his limited knowledge. The majority of the students with positive computer attitudes also indicated wanting to improve their digital skills (83%). Nkateko indicated

relying on himself with the majority of the other students surveyed (21%) as well as his mobile phone (17%). Concentrating on the issue at hand component of the nodes, Nkateko was only one of the 21 students (7%) who indicated in the online questionnaire that he experience the barrier of software language or terminology to his effective use of ICTs. As with the majority of the students (32%) he found that he, himself was an enabler to his interaction with digital devices. When asked to provide a definition of digital literacy, Nkateko indicated that it was a functional skill aligning himself with the majority of the surveyed students (69%). Nkateko was one of the minority of students (21%) with an average digital self-efficacy level. He confirmed statistical results provided in table 36 which showed that students with an average DSE are more likely to have failed the baseline test (52%). Nkateko was one of the majority of students with an average DSE who failed the baseline test (52%). Only 34% of the self-rated intermediate students had an average DSE level. Nkateko fell in the majority of the students with average DSE levels who indicated they wanted to improve their digital competence skills (89%).

Both Devi and Nkateko were self-rated intermediate ICT users and this was not the first time both of them were using digital devices. They were both in the minority of the students surveyed in that they both scored themselves as having positive computer attitudes and average beliefs in their own abilities. Comparing Devi and Nkateko's learning networks I saw that the initiator components of the nodes differed in their gender, race and home language. Their only similarity was their age. Devi relied on various resources, such as, people, course material, her mobile phone, computer and previous experience, to help her become digitally competent. Nkateko reported that he only had himself and his mobile phone to rely on. However, this reliance on resources is debatable as Mandy earlier reported that she relied on six resources and yet she still failed the test. The issues at hand components of identified barriers and enablers were different. They had similar practices as they were both not first time users, used ICTs to complete assignments and play games. They were both teaching other individuals to use digital devices. These two students were interesting to compare as they scored their digital self-efficacy levels and computer attitudes lower than the majority of the other students surveyed. I offered a tentative explanation in 8.2.1.1. that the more successful Thandi experienced no barriers and was an advanced ICT user, whereas, Mandy listed two barriers and was a beginner ICT user. This explanation is negated in my comparison of Devi and Nkateko. The commonality that I identified in Mandy and Thandi's learning networks is not evident in an analysis of Devi and Nkateko's learning networks.

Both Devi and Nkateko are intermediate ICT users and both list one barrier to their effective engagement with ICTs. However, Devi passed the test and Nkateko failed it. The last pair of students I compare are Zenzi and Margaret.

8.2.1.3. Zendzi and Margaret

Zendzi and Margaret were two students who differed greatly in age. Zendzi was 40 years old, while Margaret was 19. They were both interviewed in 2013. Zendzi initially failed the test with a score of 42%. She passed the test on her second attempt with 62%. Margaret passed the test with a score of 74%. While Zendzi rated herself as a beginner ICT user, Margaret rated herself as an advanced user. Margaret was a white student whose home language was Afrikaans. Zendzi was a black African student whose home language was isiXhosa. However, despite these differences, both had a very similar positive computer attitude rating, with Zendzi scoring herself 130 and Margaret scoring herself slightly lower at 124. Again, both students had a strong belief in their own digital abilities with Zendzi rating herself as having a DSE score of 131 and Margaret, 136.

They both wanted to improve their digital competence skills. Zendzi because she felt it would make her life easier: "*I wanted to improve so that I can be able to my assignments and for future I can be able to assess the other computer programmes*" and Margaret because *"technology is constantly changing. I want to be able to keep up with the rest of society.*" Zendzi stated that she would be relying on herself, playing on her mobile phone and using a computer to improve her digital literacy skills. Margaret detailed relying on her family, friends and courses she was taking at the HEI to assist her in this development. Zendzi believed that the portability of digital devices enabled her to effectively engage with ICTs whereas Margaret mentioned peers demonstrating skills to her and her own efforts of trial and error. In the online questionnaire Zendzi felt the inconsistency of the software on devices hampered her effective use of ICTs. In her interview, she stated that nothing made it difficult for her to use ICTs. She had access to ICTs and possessed her own laptop at home. Margaret mentioned software issues as a possible barrier in her interview. The inconsistency of the placement of icons between various devices hindered her as is evident in her statement: "*because the icons of laptop are in one place other than the desktop*". In her interview, Margaret expanded on this notion of inconsistency with her comment that the different brands available, such as, MacBook versus Windows. She continued to say that as she had a MacBook, "*using another person's computer was quite a challenge*". In the online

questionnaire she felt that when she did decide to use them, manuals did not have enough information in them.

Even though both of these students had used ICTs before, their previous experience with and primary use of them differed. Zendzi had worked previously. She was a teller who sold stamps and although the computer was pre-programmed, she used Microsoft Excel and Word to send statistics to the Head Office. She also often sent emails. Margaret acknowledged that she was privileged to have had access to ICTs since the age of 11. Both students used ICTs for their HEI assignments, emails as well as for social networking. Zendzi also mentioned playing games. Zendzi was teaching her three young children to use ICTs at home, while Margaret did not teach anyone on a regular basis, but would help friends when they needed, especially when assignments were due.

Margaret passed the baseline test and was not required to attend the first year course lectures whereas Zendzi had failed the test and was required to attend the lectures. Zendzi enjoyed using ICTs as "*everyday there is a new thing that I learn. I feel so happy that I am becoming computer literate*". Margaret mentioned feeling confident and creative when using ICTs. She would never handwrite an assignment if she could choose between typing and writing it. Even though both students wanted to improve their digital competence skills, they felt they were forced by the courses they were taking at the HEI to improve their skills. Margaret mentioned that all of her assignments had to be typed and she felt this forced students to "*engage with and practise their digital literacy skills*". Zendzi, while feeling forced, said it was to make her "*become better*". They both accepted the necessity of improving their digital skills in a positive way.

When asked how she had come to be digitally competent, Zendzi explained that she had training on computer courses at her previous place of employment. She continued explaining that she had decided to take a course herself before she enrolled at the HEI. She said she wanted to become better for herself. Margaret said that she learnt through playing games on the computer since a young age. Margaret had also completed multiple courses at school and did all her high school assignments on the computer.

In table 47 below, I document the components that make up the nodes constituting both Zendzi and Margaret's networks of learning. I highlighted in grey the commonalities between these two very different students' experiences of coming to be digitally competent.

Table 47: Node components of Zendzi and Margaret's networks of learning

Node components	Zendzi	Margaret
Issues at hand	Positive computer attitude Strong belief in own digital self-efficacy Enabler – portability of devices Barrier – software issues	Positive computer attitude Strong belief in own digital self-efficacy Enabler – experience Enabler – digitally competent others Barrier – software issues Barrier – support material
Initiators	Self Female 40 years old African HEI courses Home language: isiXhosa	Self Female 19 years old White HEI courses Home language: Afrikaans
Practices	Failed test Beginner ICT user Attends the lectures Not first time use Assignments Emails Games Social networking Teaches her children	Passed test Advanced ICT user Not attending lectures Not first time user Assignments Emails Social networking Teaches her peers
Participants	Self Digital devices Digital literacy tutor – as she attends the lectures	Self Digital devices Family Friends Courses
Resources	Self Mobile phone Computer	Friends Family Courses Previous experience

Zendzi and Margaret were two very different students in race, age, home language and previous experience in the use of ICTs. Their networks of learning were different. Each of the nodes or actors within their unique network was comprised of different elements. While these two students were the same gender, had the same attitude towards ICTs as well as the same belief in their own ability, their networks of learning were unique to them and their previous and current experience. While both Zendzi and Margaret had the same scores in the

CA and DSE scales, they differed vastly in their test results. Zendzi relied on non-human resources, whereas, Margaret engaged with people and courses in her learning network. They were the only two students that experienced the same barrier of software issues. However, one passed the test and the other failed. A tentative explanation could be that this identified barrier of software issues did not have a great impact on their development of digital competence as initially thought.

In figure 47 I present Zendzi's network of learning to become digitally competent. The positively charged nodes included: the enabler of the portability of devices, her strong DSE and positive CA. I included the fact that she was not a first time ICT user, was attending lectures and was teaching her children how to use ICTs. The negatively charged nodes included: failing the test, experiencing software issues as a barrier to her effective learning. She was also a self-rated beginner ICT user. I left the neutral nodes or actors un-highlighted. These are the demographics of the initiator, namely, Zendzi's race, gender and age. It could be argued that Zendzi was a digital immigrant and this may have hindered her as she started the process of becoming digitally competent. However, age as not found to be a determining characteristic in baseline test success. Overall, Zendzi's network of learning was positively charged.

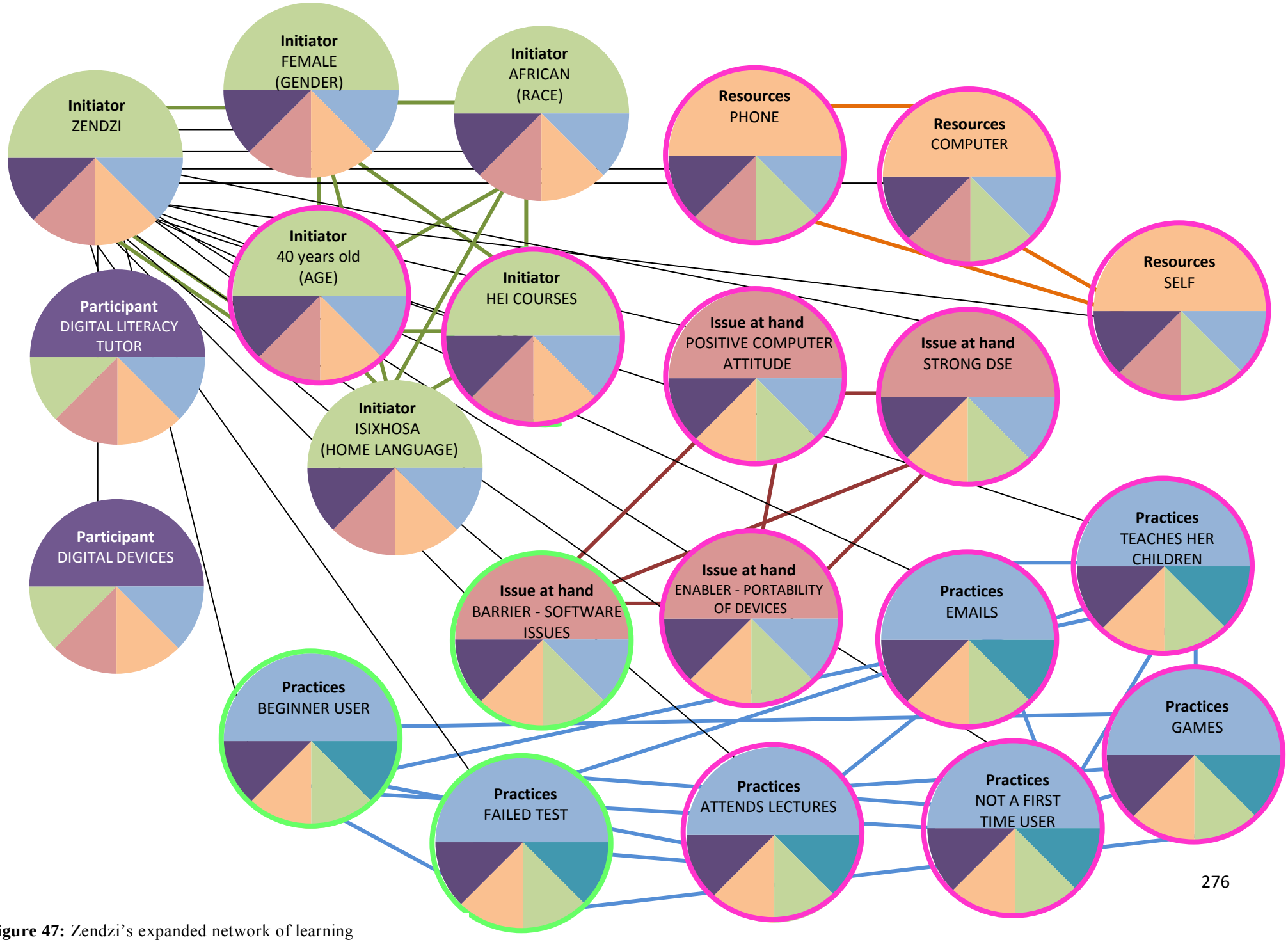


Figure 47: Zendzi's expanded network of learning

Zendzi was the key **initiator** in her network of learning. She was a female, African, Xistonga speaking, student. She is the oldest student interviewed at 40 years old. She indicated in her interview that she wanted to improve her digital competence to make her life easier. The **resource** nodes that Zendzi relied on in her network of learning were herself, her mobile phone and computers. The **participant** I identified in her network of learning was herself and the digital literacy tutors as she was attending the lectures. The **practices** or interactions with other nodes that the initiator, Zendzi, carried out using the available resources included completing assignments, playing games, sending emails, social networking and failing the baseline test, being a beginner ICT user and at that moment teaching her children how to use ICTs. Zendzi rated herself as a beginner ICT user and her first year at the HEI was not her first time using digital devices. The component of the nodes that I was most interested in is the **issue at hand**. In the online questionnaire Zendzi identified icons on a laptop being in a different place to those on a desktop computer as negatively impacting on her engagement with ICTs. Later in her interview, she said she experienced no barriers. The enabler that she experienced was the portability of digital devices. Similar to the previous two students, Devi and Nkateko, Zendzi had a positive computer attitude. However, she also had a strong digital self-efficacy level. The mediator I focused on was the baseline test result. Zendzi failed the test and she had to attend the first year digital competence course lectures.

Zendzi was in the minority of the students that failed the baseline test. Most of the students who indicated they were beginner ICT users, failed the test (64%). The majority (50%) of the students surveyed indicated having a positive computer attitude. Zendzi was one of these students in addition to being one of the 7% Sesotho speaking students. Zendzi was also in the minority (4%) of the students in the 31 years plus age category. She was an example of one of the majority of the students who failed the test and had a positive computer attitude (50%). She was in the minority of the 41% of the self-rated beginner students who had a positive computer attitude. Similar to 64% of the other beginner students and 93% of the students who failed the baseline test, Zendzi wanted to improve her digital competence skills. In line 19% of the students surveyed, she indicated that improved skills would make her life easier. The majority of the students with positive computer attitudes also indicated wanting to improve their digital skills (83%). Zendzi indicated relying on herself with the majority of the other students surveyed (21%) as well as her mobile phone (17%) and computer (54%). Concentrating on the issue at hand component of the nodes, Zendzi was only one of 9% of students who indicated in the online questionnaire that she experienced software issues as a

barrier to her effective use of ICTs. She found that the portability of the device was an enabler to her interaction with digital devices along with 4% of the students. When asked to provide a definition of digital literacy, Zendzi stated that it was a technology site domain and this fell into one of the 3% of undecipherable answers. This may be of little significance as Zendzi rated herself as a beginner ICT user and her inexperience in the ICT field may have hindered her being able to define digital literacy. Zendzi was one of the minority of students (36%) with a strong digital self-efficacy level. Forty-nine percent of students with a strong belief in their digital self-efficacy passed the test which showed that students with a strong DSE were more likely to pass the baseline test. Zendzi was one of the 49 (45%) students with a strong DSE who failed the baseline test. Only 31% of the self-rated beginner students had a strong DSE level. Zendzi fell in the majority of the students with strong DSE levels who indicated they wanted to improve their digital competence skills (83%).

In figure 48 below, I present a diagram of Margaret's expanded network of learning. Unlike Zendzi, it could be argued that Margaret was a digital native. Overall, Margaret's network of learning was positively charged. I identified three negatively charged nodes that could impact negatively on Margaret's learning network of coming to be digitally competent. Margaret was not attending lectures and identified the lack of adequate support material and software issues as barriers to her effective engagement with ICTs.

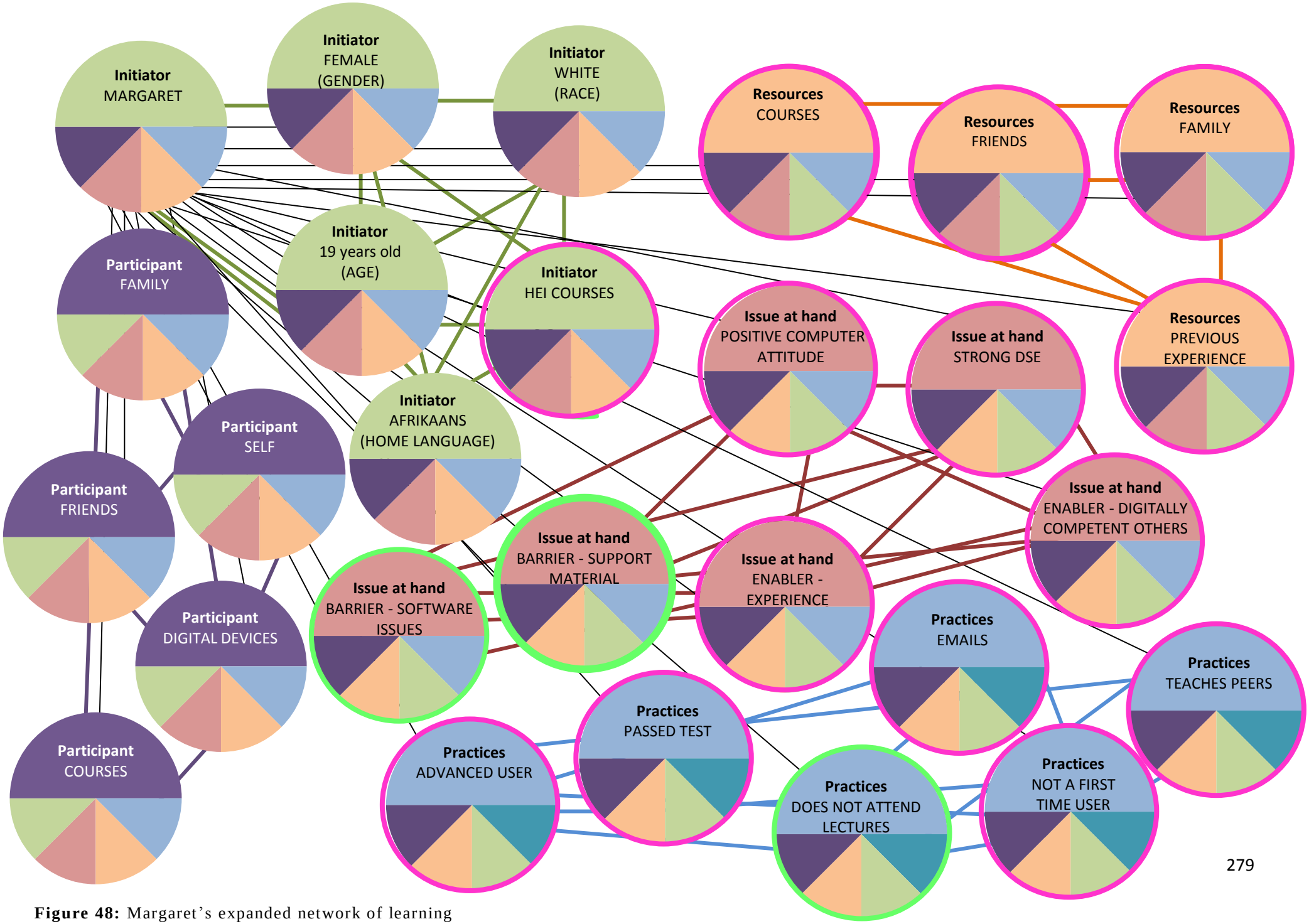


Figure 48: Margaret's expanded network of learning

Margaret was the key **initiator** in her network of learning. The other four nodes in which the initiator category is highlighted define Margaret. She is female, White, Afrikaans speaking, 19 years old and she indicated in her interview that she felt forced by the first year digital competence course to improve her digital skills. The **resource** nodes that Margaret relied on in her network of learning were herself, her friends, family, previous experience and courses. The **participants** I identified in Margaret's network of learning were herself, family, friends and courses. She said that her family, friends and courses at the HEI would assist in developing her digital competence. The **practices** or interactions with other nodes that the initiator, Margaret, carried out using the available resources included completing assignments, sending emails, engaging in social networking, passing the baseline test, being an advanced ICT user and at that moment teaching her peers how to use ICTs. Margaret rated herself as an advanced ICT user and her first year at the HEI was not her first time using digital devices. The component of the nodes that I was most interested in is the **issue at hand**. Margaret identified the barriers of inadequate support material and software issues as negatively impacting on her engagement with ICTs. The enablers that Margaret highlighted were her previous experience with ICTs and having digitally competent peers to demonstrate things to her. Like the previous three students analysed, Margaret only had a positive computer attitude. Like Zendzi, she had a strong digital self-efficacy level. The mediator I focused on the previous students' networks is the baseline test result. Margaret passed the test and as a result, did not attend the first year digital competence course lectures.

Margaret was in the majority of the students who passed the baseline test. Ninety percent of the students who indicated they were advanced ICT users, passed the test. The majority (50%) of the students surveyed indicated having a positive computer attitude. Margaret was one of these students in addition to being one of the 5% of English or Afrikaans speaking students. Margaret was also in the majority (70%) of the students in the 18 to 19 age category. She was in the majority of the students who passed the test and had a positive computer attitude (47%). She was only one of five students (3%) of the self-rated advanced students who had a positive computer attitude. Similar to 62% of the other advanced students and 75% of the students who passed the baseline test, Margaret wanted to improve her digital competence skills. Unlike the majority of the students surveyed, she indicated that this was due to advancing technology (17%). The majority of the students with positive computer attitudes also indicated wanting to improve their digital skills (83%). Margaret indicated relying on family (15%), friends (15%) and courses (4%). Concentrating on the issue at hand

component of the nodes, Margaret was only one of the four students (1%) who indicated in the online questionnaire that she experienced the barrier of software and support material (1%). As with the majority of the students (32%) she found that her previous experience was an enabler to her interaction with digital devices. When asked to provide a definition of digital literacy, Margaret indicated that it was a functional skill aligning herself with the majority of the surveyed students (69%). Margaret was one of the minority of students (36%) with a strong digital self-efficacy level. She confirmed statistical results provided in table 36 which showed that students with a strong DSE were more likely to have passed the baseline test. Margaret was one of the majority of students with a strong DSE who passed the baseline test (49%). Only 3% of the self-rated advanced students had a strong DSE level. Margaret fell in the majority of the students with strong DSE levels who indicated they wanted to improve their digital competence skills (83%).

Zendzi and Margaret were two students who differed the most. I expand on this in table 48 which follows later in this chapter. They differed in age, home language, race, self-rated ICT ability, baseline test result. They were both in the majority of the students surveyed in that they both scored themselves as having positive computer attitudes. They were in the minority with strong beliefs in their own abilities. Zendzi relied on various tangible physical resources to help her become digitally competent, whereas Margaret relied on other people. Like Devi and Nkateko, Zendzi also detailed using her mobile phone to assist her. The issues at hand components of identified barriers and enablers were different. They had similar practices as they were both not first time users, used ICTs to complete assignments, send emails and play games. They were both teaching other individuals to use digital devices. A tentative explanation may be that the large age difference between the two students may have had an impact. Zendzi was one of the oldest students surveyed, and while the surveyed students did not highlight age as a barrier in their successful engagement with ICTs in chapter six, it is possible that this factor came into play in Zendzi's network of learning. Margaret detailed being able to rely on friends and family, as well as, ICT courses and her previous experience with digital devices. Zendzi on the other hand, had limited resources and told me that she only had herself and digital devices to rely on. It is possible that Zendzi's age and her limited resources may have impacted negatively on her network of becoming digitally competent.

8.3. Discussion

In educational research, important questions are opened up when we consider how things work in and through complex human-non-human relations to enact social worlds, expertise, learning, pedagogy, policy and curriculum (Fenwick & Edwards, 2010). In the above figures, I made explicit the basic nodes within each student's network of learning. Networks appear to settle into a stable process or object that maintains itself. Like a black box, a network appears immutable and inevitable, while concealing all the negotiations that brought it into existence. Educational examples of this would be a mandated list of teaching competencies, or a so called evidence-based educational practice (Fenwick & Edwards, 2010). The networks I detailed are parts of a greater network or even of other networks with the student's life. Each entity also belongs to other networks in which it is called to act differently, taking on different shapes and capacities. When translation has succeeded, the actor-network is mobilised to assume a particular role and perform knowledge in a particular way (Fenwick & Edwards, 2010). I wanted to identify commonalities in successful networks so that translation could be promoted in less successful learning networks.

In everyday practice, within the practices of learning enacted by children in a classroom or the practices of workers in contexts ranging from a construction site to a surgical theatre, forms of knowledge are circulating and being enacted. In some ways then, the everyday is pedagogical, even if not always educational. Some call this competence. However, the danger is to assume that competence resides in the individual or group of human subjects who are participating together in an occasion. This assumption overlooks the important types of connection among them (Fenwick & Edwards, 2010). These connections could even be the students teaching each other. The students I interviewed detailed in the practice component of the nodes of their learning networks teaching others how to use ICTs, as well as, relying on their peers, family, friends and digitally competent others to develop their own digital competence. Competence is an effect, not the driving force for making things happen. The students may not intentionally set out to become digitally competent. By playing around, as Mandy said earlier, they learnt how to do things on digital devices. It was not a conscious decision – "*Right – now I am going to learn how to use a computer*." Digital competence was the effect of this experimentation with the device and its possibilities. For ANT researchers, competence is a knowing-in-practice produced by a particular mix of action with things. Elements interact in the network of knowledge to produce an effect of competence. Anything that appears to be passive, such as digital device, is in fact a package of sedimented

or taken for fact knowledge. The digital device was produced through histories of innovation (research, design, development), prompted by other networks. The digital device, such as a computer or mobile phone, affords a series of tangible, material possibilities. The first year pre-service teaching students encounter the digital device. They act upon themselves to accommodate the action required to operate the device, even comply with a lecturer's or fellow student's gaze, or complete a task. In this way, "learning…is seen as the outcome of a process of local struggle and that struggle is many faceted, involving the self-acting upon itself, as well as upon others and upon the material world" (Fox, 2000, p. 860).

The problem of differences in knowledges of the same thing across different regions is not particularly new. What does it mean to be digitally competent? It is different for each person. Five of the six students felt that it was a functional skill. ANT-orientated approaches can help make visible the processes and complexities of these different simultaneous ontologies and the potential of network relations enacted within them (Fenwick & Edwards, 2010). ANT does not conceptualise agency as an individuated source of empowerment rooted in conscious intentions that mobilise action. Instead, ANT focuses on the circulating forces that get things done through a network of elements acting upon one another. "Action is done under the full control of consciousness; action should rather be felt as a node, a knot, and a conglomerate of many surprising sets of agencies that have to be slowly disentangled. It is this venerable source of uncertainty that we wish to render vivid again in the odd expression of actor-network" (Latour, 2005, p. 44). Embarking on my research I intended to rationalise and document the linear path a student followed as they became digitally competent, advancing from novice to master. I intended on identifying common barriers and enablers to the research student population. I had pre-determined ideas about the impact of computer attitude and digital self-efficacy on the successful development of digital competence.

In table 48 below, I combine tables 45, 46 and 47 and identify commonalities and, more importantly, the differences between the six interviewed students.

Table 48: Node components of the six phase two students' networks of learning

Node components	Mandy	Thandi	Devi	Nkateko	Zendzi	Margaret
Issues at hand	Very positive computer attitude Very strong belief in own digital self-efficacy Enabler – experience Barrier – typing skills Barrier – software programmes	Very positive computer attitude Very strong belief in own digital self-efficacy Enabler – experience Barrier - none	Positive computer attitude Average belief in own digital self-efficacy Enabler – support material Enabler – experience Barrier – support material	Positive computer attitude Average belief in own digital self-efficacy Enabler – self Enabler - access Barrier – software language	Positive computer attitude Strong belief in own digital self-efficacy Enabler – portability of devices Barrier – software issues	Positive computer attitude Strong belief in own digital self-efficacy Enabler – experience Enabler – digitally competent others Barrier – support material
Initiators	Self Female 18year old African Home language: Sesotho More digitally competent peers	Self Female 18 year old African Home language: isiZulu	Self Female 18year old Indian Home language: English	Self Male 18 year old African Home language: Xistonga	Self Female 40 years old African HEI courses Home language: Sesotho	Self Female 19 years old White HEI courses Home language: Afrikaans
Practices	Failed test Beginner ICT user Attends the lectures Not first time use Emails Doesn't teach anyone	Passed test Advanced ICT user Not attending lectures Not first time user Assignments and social networking Teaches her peers and sisters	Passed test Intermediate ICT user Not attending lectures Not first time use Assignments Games Social networking Teaches younger brother	Failed test Intermediate ICT user Attending lectures Not first time user Assignments Games Teaches friends Teaches siblings	Failed test Beginner ICT user Attends the lectures Not first time use Assignments Emails Games Social networking Teaches her children	Passed test Advanced ICT user Not attending lectures Not first time user Assignments Emails Social networking Teaches her peers
Participants	Self Digital devices Digital literacy tutor	Self Digital devices Peers	Self Digital devices Family Digitally competent others	Self Digital devices Digital literacy tutor	Self Digital devices Digital literacy tutor	Self Digital devices Family Friends Courses
Resources	Self Peers Course material Digitally competent other Computer Previous experience	Self Peers Previous experience	Family Course material Digitally competent others Computer Mobile phone Previous experience	Self Mobile phone	Self Mobile phone Computer	Friends Family Courses Previous experience

Examining table 48 above, the only commonalities between the six students are that they are the initiators and participants in their own development of digital competence and none of them are first time ICT users. The other highlighted participant component of a node in their network of learning is that they all interact with digital devices. There are no common issues at hand. There are no identified consistent commonalities between practices. The resources the students reported relying on all differ. In the descriptions of each of the six students I documented where they are in relation to the majority of the 307 surveyed students. I now draw on these findings to identify a student that is **most characteristic** of the research population. I wondered whether such a student's learning network could provide an insider view to the majority of the other students? Here I utilise the ANT notion of translation. In education, translation provides a new language and a richly materialised conception to intervene more precisely, more honestly, within the messiness and multiplicity that make up those processes that we refer to as learning and teaching, curriculum and pedagogy, educational implementation, reform and evaluation. This process helps to unpick practices, processes and precepts to trace how things come to be. Using translation I focused on what actually happened at each of the micro-connections among heterogeneous things that are holding together to form what sometimes appears to be an immutable pattern, or an object with properties (Fenwick & Edwards, 2010).

I looked specifically at whether the interviewed student was in the majority of students who passed the baseline test. I examined their self-rated ICT ability with regards to their baseline test result, desire to improve their skills, computer attitude and digital self-efficacy level. Other factors I took into consideration were their computer attitude level, digital self-efficacy level, their home language and age. I established whether they were in the majority of the surveyed students with regards to their computer attitude or digital self-efficacy and their desire to improve their skills. I considered their baseline test result in conjunction with this. The majority of students indicated they wanted to improve their skills regardless of their self-rated ICT ability, computer attitude or DSE. I was interested in the reason they gave for this. I looked for commonalities in who and what the students relied on in developing digital competence. I investigated the barriers and enablers in addition to their definition of digital literacy. In table 49 below, I compare the six interviewed students and their relation to the rest of the 307 phase one students that completed the online questionnaire.

Table 49: Comparison of the six phase two students and their relation to the majority of the 307 students surveyed.

	Mandy	**Thandi**	**Devi**	**Nkateko**	**Zendzi**	**Margaret**
Pass or fail baseline test	Minority	Majority	Majority	Minority	Minority	Majority
Pass or fail & self-rated ICT ability	Majority	Majority	Majority	Minority	Majority	Majority
Computer attitude	Minority	Minority	Majority	Majority	Majority	Majority
Home language	Minority	Majority	Minority	Minority	Minority	Minority
Age	Majority	Majority	Majority	Majority	Minority	Majority
Pass or fail & computer attitude	Minority	Majority	Minority	Majority	Majority	Minority
Self-rated ICT ability & computer attitude	Minority	Minority	Majority	Minority	Minority	Minority
Self-rated ICT ability & desire to improve skills	Majority	Majority	Majority	Majority	Majority	Majority
Pass or fail & desire to improve skills	Majority	Majority	Majority	Majority	Majority	Majority
Reason to improve skills	Minority	Minority	Minority	Majority	Minority	Minority
Computer attitude & desire to improve skills	Majority	Majority	Majority	Majority	Majority	Majority
What relied on to improve skills	Majority	Majority	Min / Maj	Min / Maj	Min / Maj	Minority
Barrier	Minority	Minority	Majority	Minority	Minority	Minority
Enabler	Majority	Majority	Minority	Majority	Minority	Min / Maj
Definition of digital literacy	Majority	Minority	Majority	Majority	Minority	Majority
Digital self-efficacy	Majority	Majority	Minority	Minority	Minority	Minority
Pass or fail and digital self-efficacy	Minority	Majority	Minority	Majority	Minority	Majority
Self-rated ICT ability and DSE	Minority	Minority	Minority	Minority	Minority	Minority
DSE & desire to improve skills	Majority	Majority	Majority	Majority	Majority	Majority
Score out of 19	**10**	**13**	**11.5**	**11.5**	**7.5**	**10**
	Majority	**Majority**	**Majority**	**Majority**	**Minority**	**Majority**

I indicate in blue if the student's response is in the minority of the larger group of 307 students' responses. Red indicates if they are in the majority. Five of the six students are characteristic of the majority of the 307 surveyed students in certain characteristics. The student most aligned with the majority is Thandi. The student least like the research population is Zendzi. Bearing in mind that these are just six examples, it is evident that an even deeper exploration of the data and more interviewed students is likely to produce interesting and possibly unpredictable results.

While one's own skill in the use of ICTs may shape one's own DSE, it is possible that one's DSE may shape the actual skill of using ICTs (Compeau & Higgins, 1995). An individual's successful performance in an activity may shape their belief in their own ability to successfully complete similar activities in the future. Having a positive attitude and a strong

belief in one's own ability to effectively complete a task may promote the successful completion of the task (Compeau & Higgins, 1995). The two appear to be co-dependent on each other. However, should an individual not be able to successfully complete a task, due to unexpected barriers such as access, age, gender, then their self-efficacy, or belief in their own ability, may be affected. This reinforces the notion that the phenomena that an individual encounters when using ICTs impacts on the final experience of developing digital competence. Should these phenomena transpire to be barriers to the effective use of ICTs, it is prudent to identify them and reduce them in order to promote effective learning and development of skills.

I anticipated that a student who did well in the baseline test would have a positive computer attitude and possess a high confidence level in the DSE scale. However, after an analysis of the responses, this would not appear to be the norm. Take for example the following students: Zendzi had a strong DSE and positive CA, yet failed the test. Mandy had a very strong DSE and very positive CA, yet also failed the test. Nkateko only had an average DSE and a positive CA and also failed the test. Devi only had an average DSE and passed the test, whereas one would have assumed with such a low belief in her own ability that she was more likely to have failed than Zendzi and Mandy. My statistical findings in chapters six and seven are just that – statistical. When examining the actual unique individual and expanding their learning networks, I realised that a student cannot be reduced to a statistic, a number, a minority or majority. Each student is distinctive and the extent of the identified differences in the node components I identified in table 48 point to this.

I am also uncomfortable proposing that Thandi is an example of the majority of the student population surveyed. In the introduction of this thesis, I stated that my interest in the necessity for a first year computer competence course was sparked by an internal debate on the need for such a course. Colleagues argued that the first year students entered the HEI already digitally competent. Thandi is an example of such a student who is already digitally competent, experiences no barriers to her effective use of ICTs and does not attend the first year digital competence course as she passed the baseline test. She has a very positive computer attitude and very strong belief in her own ability. She is the perfect student! Yet, my findings in chapters five, six and seven indicate that there are many outliers and students enter the HEI with differing levels of digital skills, experiences, barriers and enablers, access to digital devices, and backgrounds.

8.4. Concluding remarks

The findings presented here demonstrate the complex and multifaceted process of coming to be digitally competent. The quantitative data was further enriched by the student's responses in the interview stage. My research findings showed that while a strong belief in your own ability was a possible indicator of future success with digital devices, computer attitude was not. It was feasible that having a **positive** attitude towards digital devices had no impact on whether the students passed or failed the baseline digital competence test. Computer attitude and digital self-efficacy were just two of the many actors interplaying in a student's network of learning to become digitally competent. This independence in the functional use of digital devices or ICTs is highlighted in the online questionnaire when I asked the students if they wanted to improve their digital competence skills and why. Of the 83% who answered **yes**, that they would like to improve their digital skills, 19% said that having better digital skills would make their life easier. Thirty-nine students answered **maybe** to the same question and one of those 39 students felt that their life would become easier with improved digital skills.

What emerged in my research and in answer to research question four: ***How do first year pre-service teaching students come to be digitally competent?*** was that computer attitude and digital self-efficacy may not be as strong a determiner of digital performance as I initially anticipated at the onset of my study. I found many other nodes come into play in a student's network of learning. By identifying a student whose learning network nodes was most common to the 307 phase two student population, I hoped to predict possible nodes that impacted, interacted, sustained and created other nodes in a successful learning network of coming to be digitally competent. While I found the six interviewed students to all interact with digital devices and be initiators of and participants in their own learning networks, the only other commonality is that they are all not first time ICT users. Having identified common barriers and enablers in chapter six, in chapter nine I recommend the common barriers that the majority of the students encounter be minimised in an attempt to enhance the possibility of successful development of digital competence. I found having a positive attitude had no impact on development of digital competence and digital self-efficacy a minimal effect.

I knew research question four was going to be the most difficult to answer. While I described the ways in which six first year pre-service teaching students experienced their own development of digital competence, I cannot document and propose a guaranteed procedure

for students to follow to become digitally competent. As my research became messier and more interesting, my focus shifted – I became intrigued by the differences, in the nuances and minutiae that made up each student's learning network. Fascinated by the linkages and associations between components that made up nodes that themselves constituted a learning network, I applied ANT in a way never tried before. In this chapter I unpacked and explored different students' networks of learning and present findings that show students have unique stories and the impact that any one node has cannot and should not be negated. Networks of learning are unique!

In the final chapter I examine the analysed results from chapters five, six, seven and eight, and identify implications and recommendations for the development of digital competence in first year pre-service teaching students at the higher education institution in South Africa.

Chapter 9 - Discussion and implications

I undertook this study when I realised there was a need to design digital competence courses for increased diversity in the first year pre-service teaching student group at the HEI. In 2013 and 2014, 43% of the students who participated in my online survey and took the baseline digital competence test, failed it. Rigorous conception of emerging digital practices coupled with expert knowledge of learning design might make the possibility of a "digital democracy" in higher education a reality (Brown & Czerniewicz, 2010). Brown and Czerniewicz (2010) expound on the term digital democracy to explain the widely unjust and varying levels of access and digital skills of the students participating in their research. Similar to Brown and Czerniewicz's research, I noticed a discrepancy in the students in my study's current digital abilities and previous experience. Exploring this further, I firstly established the students' levels of digital competence as they entered the HEI in chapter five, and secondly, identified barriers and enablers that either enhanced or constrained this development in chapter six. Thirdly, I determined the students' computer attitude and digital self-efficacy levels in chapter seven. Finally, employing an actor network theory analysis approach, I detailed the learning networks of six students in chapter eight. My findings contribute to the efficient learning design Brown and Czerniewicz speak of for enhancing future success in similar groups of students.

9.1. Research findings

The purpose of my research project was to explore the development of digital competence in first year pre-service teaching students at the HEI. I explicitly looked at the impact that computer attitude and digital self-efficacy may have had on this development. The overarching question which my research sought to answer is:

What role do digital self-efficacy, computer attitude and other factors play in the development of digital competence in first year pre-service teachers at the HEI*?*

I set out to answer the following sub-questions:

1. What are first year pre-service teaching students' perceptions of digital competence?
2. What are first year pre-service teaching students' current levels of digital competence?
3. What factors inhibit or afford the development of the first year pre-service teaching student's digital competence?

3.a. What relationship is there (if any) between computer attitude and a student's attainment of digital competence?

3.b. What role does a belief in one's own ability to use ICTs (self-efficacy) play in the development of digital competence?

4. In what ways do first year pre-service teaching students develop digital competence in a first year ICT course?

In this final chapter, I draw together the various strands of my study to answer my research questions and outline implications for other similar studies and for the development of digital competence in first year pre-service teaching students at the HEI. In the sections that follow, I address my research questions and discuss the implications of my findings for each one.

9.1.1. First year first year pre-service teaching students' perceptions of digital competence (RQ1)

I explored the students' perceptions of what it meant to be digitally competent in chapter five by analysing the 307 students' responses from the online questionnaire. I considered competences that made up a definition of digital competence and established to what extent the first year pre-service teaching students' understanding of digital competence was congruent with this. In table 1 I constructed a definition framework that correlated with components of digital competence by summarising Covello's (2010) six sub disciplines of digital literacy, Eshet-Alkalai's (2004) five literacy skills, Hague and Payton's (2010) eight components of digital literacy and JISC and McHardy's (2013) seven elements of digital literacy. I linked these components to Binkley, and fellow researchers' (2010) 21st Century skills. I identified six key digital competencies; online skills, information skills, communication skills, collaboration skills, functional skills and career skills. In the online questionnaire I asked the students: *What do you understand the term digital literacy to mean?* Using a coding scheme I coded the data and established that the majority of the students' (69%) felt that **functional skills** were the most important of the six key competences in digital competence. While collaboration skills were not mentioned at all by the 307 students surveyed, 12% of the students noted online skills, 6% listed information skills, 6% communication skills and only 1% career skills.

I investigated whether age, computer attitude, digital self-efficacy levels, baseline test results or self-rated digital ability impacted on these findings. Regardless of the above mentioned categories, the majority of the students listed functional skills in their answer to the question.

For my research population, functional skills – being able to use the digital device independently, was a key skill to possess. I deconstructed Ferrari's 2012 comprehensive definition of digital competence and mapped my findings onto her meaning and constructed a definition specific to the group of 2103 and 2014 pre-service teaching students at the HEI. Digital literacy was defined as ***the set of knowledge and skills that are required when using ICT devices to perform tasks and communicate for work.*** This perception of digital literacy is specific to this research population and highlights their focus on functional skills as a key digital competence skill.

The literature definition of digital competence focused on the notion of independence – digital competence being the essential knowledge needed to function independently with digital devices. Advancing on this notion of independence, I asked the students **who** was teaching them to become digitally competent. Twenty-one percent answered themselves, 17% mentioned a digital literacy tutor, 15% friends, 15% family. I then asked them **what** they were using to help themselves become digitally competent. Fifty-four percent said a computer, 17% a mobile phone, 5% the Internet and 4% courses. I discovered that 51% of the participants already owned their own computer and 83% owned a mobile phone. When asked if they wanted to improve their digital competence skills, 83% indicated yes. Of these, 19% of the students said that improved digital competence skills would make their lives easier.

I found no significant relationship between computer attitude, digital self-efficacy level, baseline test result and the students' definition of digital competence. The majority of the students indicated functional skills regardless of their age, computer attitude, digital self-efficacy level or whether they had passed or failed the baseline test.

9.1.2. First year pre-service teaching students' levels of digital competence when entering the HEI – 2013 to 2014 (RQ2)

The first year pre-service teaching students of 2013 and 2014 completed a baseline digital competence test as they entered the HEI. Passing this test exempted them from attending the first year digital competence lectures. In chapter five, findings from the test showed that 57% of the pre-service teaching students who completed my online questionnaire and took the baseline test in 2013 and 2014 entered the HEI possessing a reasonable degree of digital competence. Forty-three percent of the students failed this test. This was low considering 98% of the students were born in a digital era, after 1980, and therefore fitting Prensky's

original definition of a digital native. However as I established, age was not a determining factor of their digital success. This is supported by Czerniewicz and her fellow researcher's description of a deepening digital divide in South Africa characterised not by age but by access and opportunity (Brown & Czerniewicz, 2010).

The students were asked to rate their own ICT ability. Eight percent rated themselves as novices, 34% beginner ICT users, 51% intermediate and 7% advanced ICT users. There was a strong significant relationship between the students' baseline test result and their self-rated ICT ability. I found that self-rated intermediate and advanced ICT users were more likely to pass the baseline test than novice or beginner users. I designed a digital competence frame drawing on the components of Dreyfus and Dreyfus' model of skill acquisition (Dreyfus, 2004) and linked this to the guidelines for teacher training and professional development in ICT (Hindle, 2007). It is suggested in Hindle's document, that a teacher should enter the profession at level two - an adoption level being able to use various ICTs, including computers, to support traditional management, administration, teaching and learning, and is able to teach learners how to use ICT. Using my digital competence frame, the pre-service teaching student should be located at a beginner level moving into a more competent level by the time they graduate from the HEI. My study of these students does not continue into their second, third and fourth years of study. Further research into their levels of digital competence when they graduate as teachers from the HEI is indicated here. However, I did find that 43% of the first year pre-service students had been hindered from developing a basic novice level of digital competence prior to entering the HEI. In answering my following question three, I established the barriers hindering these students' successful development of digital competence.

9.1.3. Factors inhibiting and affording the first year pre-service teaching students' development of digital competence (RQ3)

In chapter six, I drew on data from the online questionnaire as well as the interview transcripts to answer my third research question. I asked the students to identify external and internal factors that impacted on their development of digital competence. The surveyed students identified fifteen factors they felt impacted negatively on their engagement with ICTs. The most noted barriers were firstly, their inexperience (24%) and secondly, access to digital devices (17%). Inexperience related to the students not having used ICTs extensively in the past. However, of the surveyed students, only 8% rated themselves as novice ICT

users and 34% as beginner ICT users. The majority of the students n=157 (51%) rated themselves as intermediate users and 7% as advanced users. Of the total number of students who failed the test, 70% of these were self-rated novice and beginner users. This shows an accurate self-assessment of their own ability and the students' self-rated lack of previous experience related strongly to their failure of the baseline test. However, interestingly, 34% of the self-rated intermediate and advanced users also failed the test. It may be likely these students had an inflated or unrealistic opinion of their own ability, rather than them being actual intermediate and advanced users who failed the test for other reasons. In chapter eight I have shown how multiple nodes can come into play in a learning network.

The barrier of access included current and previous access to ICTs. Other identified barriers included software not being user friendly (9%) and software language, such as the technological jargon and terminology (7%). The barrier of advancing technology included the complexity of devices (6%) and hardware issues related to battery life and hardware failure (4%). Some students (3%) felt their poor typing skills hindered them, while a lack of access to the Internet was experienced by 2%. Lack of adequate support in the form of material, manuals, information or a knowledgeable teacher was identified by four (1%) of the surveyed students. Similarly, only a few students listed technophobia or the fear of technological or digital devices (1%), physical factors such as poor eyesight (1%), and lack of time to become familiar with the devices (1%) as barriers. Only one student listed financial constraints when buying data or actual devices 0.2%. One student mentioned her own attitude or lack of patience to learn how to use a new device (0.2%). Notably 10% of the students experienced no barriers. A large number (12%) left the question unanswered. As the majority of the students did not speak English as their home language (78%), I had expected language to feature more strongly as an identified barrier.

While Darkenwald and Merriam identified situational, institutional, informational and psychological learning barriers, the students experienced predominantly situational and psychological barriers. Research questions 3a and 3b in my study focused on the psychological barriers of computer attitude and digital self-efficacy. However, these were not identified by the students as possible barriers impacting negatively on their development of digital competence. I found a strong statistical significant relationship between a student's self-rated digital competence level and the barrier they indicated as hindering their effective ICT use. Regardless of whether the students were novice, beginner, intermediate or advanced

ICT users, they all experienced situational barriers more acutely. However, the intermediate and advanced students did not experience the barriers of inexperience and access as strongly as the beginner students did. Nine percent of students in both the intermediate and advanced groups stated that they did not experience any barriers at all.

The students identified enablers that impacted positively on their engagement with ICTs. The most noted enabler was experience in using ICTs previously (32%). The second most noted enabler was previous and current access to ICTs (13%). User-friendliness of software (10%) and support in the form of support material or people (10%) was also seen as an enabler. Other enablers included the user-friendliness of the actual digital device itself (7%) and portability of the digital device (4%). Eleven (4%) of the students mentioned themselves and their curiosity and desire to learn new things. Ten students (3%) detailed the relevance and convenience of ICTs in their lives. Internet access was also seen as an enabler (2%). Five (1%) students felt their ability to understand the terminology as well as the commonality of applications on different devices assisted them. Identified as a barrier, typing skills were again identified as assisting them by 2 (0.7%) students. One (0.3%) student felt her young age helped her. Fifteen (5%) felt that nothing helped them and 7% of the students did not answer this question.

The situational barrier of inexperience and access were identified as the main barriers that led to the breakdown of a student's learning network of coming to be digitally competent. These two barriers are interlinked and inexperience may have resulted due to a lack of previous access to ICTs. While there were similarities between the barriers identified in the literature and those identified by the students, certain barriers were unique to my research population. In the data collected from the online questionnaire, no mention was made of the following factors highlighted in the literature; human, age, geographic location, cultural, gender, race or illiteracy. However, even though the students did not explicitly identify these barriers, does not mean that they did not experience them. A lack of access could include any of these barriers. I do not ignore the effect these underlying factors could have had on the students' inexperience in using ICTs, or even their access to ICTs. As ANT theorists explain, society consists of networks of any material entity, human or non-human (Ellis, 2013). Both human and non-human elements are considered as equal actors within a network (Cressman, 2009). As I show later when answering research question four, the identified barriers were human and non-human actors within the students' networks of learning.

9.1.3.1. Computer attitude and the students' attainment of digital competence (RQ3a)

Research shows that a positive or negative computer attitude can help or disadvantage an individual's development of digital competence. Findings from RQ2 showed that the students did not experience many psychological barriers. I found that only four students detailed technophobia as a barrier and one felt her attitude hindered her. Using Loyd and Gressard Computer Attitude Scale (Appendix B), I established that 35% of the 307 students had a **very positive** attitude towards using digital devices, while the majority (50%) had a positive attitude. None of the students exhibited a **very negative attitude** and only two students indicated that they had a **negative attitude**. Comparing student computer attitude and baseline test results revealed more students (60%) with an **average** computer attitude passed the test. Surprisingly more students with a **positive** attitude failed than passed the test. The literature presupposes that students with a **negative** or **average** attitude would be less likely to perform well in the baseline digital competence test. My findings suggest otherwise. Statistics showed a **positive** attitude in my research population of first year pre-service teaching students at the HEI in 2013 and 2014, had little impact on them passing or failing the first year digital competence test.

The two students who indicated they had a **negative** computer attitude were beginner ICT users. The majority of the students (49%) who had an **average** attitude were intermediate ICT users. This is similar to the students with a **positive** attitude also stating they were intermediate ICT users (46%). Sixty-one percent of students with **very positive** attitudes also rated themselves as intermediate ICT users. Statistics showed a statistically significant relationship, with a small effect size, between the students' computer attitude and their self-rated ICT ability. The majority of both the self-rated novice (n=16), beginner (n=63) and intermediate (n=71) ICT users had **positive** attitudes towards ICTs. The majority of the self-rated advanced (n=14) ICT users had **very positive** attitudes towards ICTs.

The students surveyed mentioned relying on themselves and using a digital device such as a laptop, computer, tablet device or mobile phone to assist them become digitally competent. Twenty-one percent of the responses indicated that they were teaching themselves to become digitally competent. I discovered that 34% of the students with **very positive** computer attitudes, 25% of the students with **positive** attitudes and 9% of the students with an **average** attitude mentioned relying on themselves in their responses. The two students with **negative** attitudes mentioned using courses and family members to help them. I also found computer

attitude and digital self-efficacy to be statistically correlated. One would expect a student with a positive computer attitude to have a strong belief in their own ability. It follows that a student with a positive computer attitude and strong digital self-efficacy level would be comfortable relying on themselves to help develop their own digital competence.

While Loyd and Gressard proposed a positive attitude towards computers as a predictor for future ICT use and academic success (Loyd & Gressard, 1984), I found no correlation between computer attitude and a student's digital competence. The majority of students who failed the baseline test had a **positive** computer attitude. While the majority who passed the test had a **very positive** computer attitude, I initially hypothesised that if computer attitude and digital success were correlated, the students who failed the test would have computer attitudes in the negative to average range. Hoping to determine computer attitude or digital self-efficacy as a key common factor in the students' successful learning networks, I realised the futility of this after my in-depth analysis of the six students' learning networks in chapter eight. I accepted the naivety of my initial pre-research hypothesis. Having conducted my research and following an ANT approach, I realise the challenges of searching for finite answers in a study such as mine.

9.1.3.2. A belief in one's own ability (DSE) and its role in the development of digital competence (RQ3b)

A strong belief in one's own ability was seen as a strong determiner in learning to be digitally competent. I used the Murphy (1989) Digital Self-Efficacy Scale (Appendix C) to establish the students' levels of DSE. I found the majority (38%) of the surveyed students had very strong DSE levels, 36% strong DSE levels, 21% average DSE levels, 4% weak DSE levels and 1% very weak DSE levels. Comparing digital self-efficacy levels and baseline test results, I found that of the three students who had a **very weak** belief in their own ability, one failed the baseline digital competence test and the other two students did not take the test. As I predicted, a large number of students (79%) with only a **weak belief** in their own ability failed the test. More students with an **average** belief in their own ability failed the test. Students with a **strong** belief (49%) in their own ability and 70% of the students with a **very strong** DSE level passed the test. Unlike my findings relating computer attitude to baseline test result, statistics showed a statistically significant relationship between the students' digital self-efficacy levels and their baseline test result. Students who passed the test tended to have higher DSE levels than students who failed the baseline test. This finding, that digital

self-efficacy is a stronger pointer towards success than computer attitude, has implications for further research. Ways in which students' digital self-efficacy can be developed should be investigated and I make some recommendations in section 9.5.2.

Statistics also revealed a statistically significant relationship between the students' digital self-efficacy levels and their self-rated ICT ability. Of the three students who indicated having a **very weak** belief in their own digital ability, one was a self-rated novice ICT user and the other two were beginner ICT users. Fourteen students had a **weak** belief in their own ability. Fifty-seven percent rated themselves as beginner ICT users. The majority of the students (58%) who had an **average** belief in their own ability were beginner ICT users. Fifty-six percent of the students with a **strong** DSE were self-rated intermediate ICT users. Sixty-one percent of the students with a **very strong** DSE were also intermediate users. The majority of self-rated beginner ICT users had a **very weak**, **weak** or **average** DSE level. Intermediate ICT users indicated having a **strong** or **very strong** DSE level. These findings were expected as both the ICT ability levels and the DSE levels were self-rated. The implication of this finding is now to suggest ways in which course organisers and presenters can develop stronger levels of digital self-efficacy in students. I present possible recommendations in table 50 that follows.

I discovered that 29% of the students with **very strong** digital self-efficacy, 26% of the students with **strong** and 22% of the students with an **average** DSE mentioned relying on themselves to develop digital competence. Only 14% of the students with a **weak** belief in their own ability reported relying on themselves, while the students with a **very weak** DSE mentioned that no one was helping them. Rather they were relying on courses, digital literacy tutors, family and friends. These findings are similar to those presented earlier in section 9.1.3.1. where I discussed the different levels of computer attitude and the students reliance on themselves. Here again, I expected students with a strong belief in their own ability responding that they were relying on themselves.

Statistics showed computer attitude was positively correlated with digital self-efficacy levels. Higher DSE values positively related to the higher CAS values as students with positive computer attitudes were likely to have strong beliefs in their own ability. The majority of the first year pre-service teaching students had a **positive** computer attitude and a **very strong** belief in their own digital ability. The majority of the students across all self-rated ICT ability levels indicated they would like to improve their digital competence skills. None of

the novice students answered no and even the advanced students wanted to better their skills. Statistics showed novices and beginners were more inclined to want to improve their skills. There was also a statistically significant relationship with small effect size between the student's baseline test result and whether they wanted to improve their digital competence levels or not. Ninety-three percent of the students who failed the baseline test indicated that they were interested in improving their skills. None of the students who failed indicated no. This would be an obvious result as on receiving the test result they would know that their digital competence levels did not meet the required standard. Only 4% of the students indicated that they were not interested in improving their skills.

The students provided reasons for wanting to improve their digital competence skills. Forty-two percent of the students realised they did not have the necessary skills or experience. Other reasons included a need to keep up with advancing technology (15%). Sixteen percent felt a certain degree of digital competence would make their life easier and assist them with their studies and in their future teaching careers. Eight percent cited their desire to learn and improve their skills and two percent indicated it was an important skill to possess. Students who did not feel the need to improve their skills said they already had the necessary skills (8%), or they were unsure if they needed to improve their skills (1%). Two students said they were too busy and two students also felt it was unnecessary or they were not interested in improving their skills. Thirty-two, (25%) of the students who indicated their limited skills as a reason for wanting to improve also listed lack of experience as a barrier to their effective use of ICTs. Statistical tests showed a strong statistically significant relationship between the students wanting to improve their digital literacy skills and the reason they gave for this. The majority of the students who indicated that they wanted to improve their skills said that this was due to their limited knowledge and weak current skills. The students who answered no, or maybe to the question asking them if they wanted to improve their digital skills, indicated that their current knowledge and skills were sufficient.

I found a statistically significant relationship with small effect size between the student's computer attitude level and wanting to improve their digital skills. Students with a positive computer attitude were more likely to want to improve their own ability. Surprisingly, students with a very strong belief in their own digital ability also mentioned wanting to improve their digital skills. These were the students I indicate that their current skills were sufficient for their needs. However, statistics showed no statistically significant relationship

between the students' belief in their own abilities and wanting to improve their digital skills. Regardless of their attitude or DSE level, the majority of the students answered that they were interested in improving their skills. The implications of this are discussed in my proposed recommendations in section 9.5.2.

In answer to the question: ***What role does a belief in one's own ability to use ICTs (self-efficacy) play in the development of digital competence?*** I found the majority of students surveyed had a **strong** or **very strong** belief in their own ability. The majority of the students who passed the test had a **very strong** DSE and the majority of students who failed had an **average** to **strong** DSE. Kay notes that favourable attitudes, as well as a strong belief in one's ability to work with computers, are necessary, but not sufficient to ensure the development of a computer competent student (Kay, 1993). As with the barriers and enablers identified when answering research question two, one single node or actor such as attitude or digital self-efficacy, cannot be deemed to impact exclusively on a student's process of coming to be digitally competent.

9.1.4. Coming to be digitally competent (RQ4)

In section 3.1. I detailed the ontological and epistemological location of my research. As an ANT researcher, I reject both modernist and postmodernist thinking about the definition of truth. For ANT, truth does exist, but it can change over time. Focus is on the forces that shape and reshape the true essences the researcher faces (Dzakiria, 2006). As a critical realist, I acknowledge that things exist, but I am aware that my presence as a researcher influences what I am trying to measure. ANT is an approach that assumes multiple causal agents operate as generative mechanisms at various levels: social, socio-economic, cultural, and or digital. Relations between these agents exist and a critical realist attempts to explain how phenomena are related to and explained by the structures underlying them (Norrie, 2005). ANT views society consisting of networks of any material entity, human or nonhuman. The agency, or capacity to act, of actors constitutes the network, rather than mere connections of human and non-human actors and in my detailing of the learning networks of the six students In this study I attempted to not lose sight of this. The important thing is not to pre-determine who or what is involved in the creation of the actor-network. Rather, all potential actors should be treated from an equal starting point (Banks, 2011).

Recognising that skill development is distributed across task, across individual, as well as, across the physical and social setting (Barab, et al., 1996), I presented and magnified the

learning networks of six students. I dissected the nodes that made up their respective learning network. Each node was broken up and its elementary features examined. By representing experience in terms of nodes and links I had a means of detailing and visualising multiple environmental particulars in one analysis. A pre-service teaching student in their first year at a HEI is not defined in the exact moment that they pass or fail the digital competence baseline test. They are defined by all the nodes that constitute the network of learning in which they are situated. I looked for commonalities in the students' descriptions of how they came to be digitally competent in order to determine a pattern that might assist course developers and presenters at the HEI when designing and presenting digital competence courses. I found the following three commonalities: The students were both initiator and participant in the network. They interacted with digital devices and were not first time ICT users. These three commonalities seem quite immaterial when compared to at least 16 differences.

I found that each student's learning network was unique. Human actors I identified were the students themselves, peers, friends, family members. Course tutors and more digitally competent others also interacted in the networks. Students were also often teaching others. Non-human actants included the digital devices themselves, course material, ICT applications Examining the connections made between these nodes I discovered that the differences in learning networks told a more interesting story than the commonalities. Through an analysis of six students' learning networks and comparing their idiosyncrasies or characteristics with the 307 students, I found one of the six students to be representative of the majority of the students (Table 49). Thandi is an example of a student who is already digitally competent, experiences no barriers to her effective use of ICTs and does not attend the first year digital competence course as she passed the baseline test. She has a very positive computer attitude and very strong belief in her own ability. She is the perfect student! Yet, forty-three percent of the first year pre-service teaching students failed the test. They did not enter the HEI already digitally competent. My findings in chapters five, six and seven indicate that there are many outliers and students enter the HEI with differing levels of digital skills, experiences, barriers and enablers, access to digital devices, and backgrounds.

Remembering that the context of my research takes place in the pre-service teaching students first year of study at the HEI, I used an ANT analysis, and showed in chapter eight that learning to be digitally competent did not necessarily take place in a computer lab at the HEI

with a digital literacy tutor teaching the students. Learning networks are unique and students learn in various ways with various participants participating in their learning. These participants could be human or non-human. They included the student him or herself as well as digital devices.

9.2. Methodological findings

There are two contributions my study can make to research methodology, specifically research into the development of digital competence. The first contribution is the successful use of the Loyd and Gressard computer attitude scale and the Murphy digital self-efficacy scale. In table 6 in section 3.3., I highlight the advantages and disadvantages of each of the data collection instruments and techniques I used. Scales are used extensively in questionnaires as they allow for a fairly accurate assessment of beliefs or opinions. A disadvantage may be that all the answers can be the same, making it difficult to differentiate between items (McMillan & Schumacher, 2006). In my study, I found the students' responses to be accurate. I was initially concerned about participant fatigue when completing a lengthy online questionnaire which included these two scales. I was worried the students would just click random answers in this self-evaluation instrument in order to quickly complete it. However, when analysing their responses, I found the students' responses to be reliable. This was evident when investigating the students' self-rated ICT ability and their baseline digital competence test result, and finding a strong Chi-square correlation in the data contained in table 26 in section 5.7.1. The students did not just click on any option, but thought about their answers. My successful use of these two scales supports the advantageous consideration of using similar scales in research. I found them to be effective, easy to administer and easy to interpret the results. Using the quantitative data collected from the scales, I was able to further link it to and enrich it with qualitative data findings.

The second, most valuable, contribution my study makes to research methodology is the practical application of actor-network theory documenting and understanding the students' unique networks of learning. I considered the human and non-human nodes that made up each of the students' learning networks and showed linkages between them. I extended Barab et al.'s definition of the components that constitute a node in a network of learning, and showed the constitution of each of the identified nodes in each student's network. I linked similar nodes together and assigned them a positive or negative quality. Indicating whether they acted negatively or positively on the network, I made a decision on the overall

"charge" of the network. I traced commonalities in the students' learning and found one student representative of the majority of 307 students surveyed. I concluded that the only common nodes were the participants in the networks – namely the students themselves and the digital device(s) they used. The students had also all had some prior exposure to ICTs before.

My application of ANT is unique and opens the possibility of it being used as an analytical tool to a range of contexts other than nursing, public health, business (Czarniawska-Joerges & Hernes, 2005), urban studies (Farias & Bender, 2010), and community, urban and regional planning (Beauregard & Lieto, 2015). ANT has also been used in contexts of international relations and political science (Cudworth & Hobden, 2013). Similar application, such as mine, in educational research and other learning situations helps reveal the connections that are made between relevant nodes. It can be used by other researchers in a variety of ways to suit their research questions. As the discourses of educators, course designers and researchers are not necessarily shared by those who are engaging in practices within those areas identified as contexts of learning, by following the actors, researchers discover various meanings and significances of practices. The question that emerges is about how to understand a teaching and learning context, when these processes are not necessarily bound by a specific set of institutional relationships and structures, but emerge from specific mobilisations as network effects. I asked myself how to better understand the learning context of coming to be digitally competent when this process did not necessarily occur formally in a bounded institution such as the HEI, but also informally in other contexts. Researchers drawing upon ANT should focus on context becoming an effect of practices rather than context being a thing (Nespor, 2003).

9.3. Critical reflection of the research process

Although ANT carries the word *theory* in its name, it is better viewed as a method for doing research. ANT indicates that once the research question has been set, and ANT selected as the research method, the first step is to choose a starting point. The actant I chose from where my research departs was the baseline test. I used the students' test results to group students into those that passed and those that failed. The students who passed this test had a suitable level of digital competence, while those who failed, did not. I investigated various variables that may have impacted on their success or failure. While Dzakiria says there is not much to guide this choice of actant or node, for ANT, there is no best or worst choice. He suggests

that theories and other presumptions should be avoided at this stage in order to ensure the full range of involved entities can be explored without researcher bias. He proposes the only guide to choosing the starting point is the theme, central question and goal of the research (Dzakiria, 2006). For my research this was the successful development of digital competence in first year pre-service teaching students at the HEI. Starting from this point I began exploring and unravelling this node and the human and non-human actors that related to it. In ANT research it is important to 'hear' the actors involved, usually through interviews and analysis of documents. I interviewed the students, analysed their baseline test results, computer attitude scales, digital self-efficacy scales in addition to their responses to numerous questions in the online questionnaire. My research is unique in its application of ANT to pre-service students looking specifically at the internal and external factors affecting how they come to be digitally competent. Hoping to better inform future practice, I looked for commonalities in the students' learning networks to establish common paths they followed in the processes of coming to be digitally competent. I also investigated the impact, if any, that computer attitude and digital self-efficacy had on this process.

I encountered several gaps or deficiencies in my online questionnaire. Even though I had piloted the questionnaire prior to my research project, there were still questions I should have included. I should have asked the students more detail on how they were helping themselves become more digitally competent. There were also questions I would have liked to have had the opportunity to revisit with them for further clarification on their answers. The use of the Survey Monkey tool was vital in helping me collect this data online. Even though it was time-consuming, having a colleague recode the data ensured the objectivity of my coding and findings. Statwing was an effective tool in providing statistical analysis of and interpretation of the data. Optimal participation in the follow-up interviews would have further enriched the qualitative data and the students' accounts of their learning situations. I was interested in how their circumstances had changed. I would also have liked them to retake the baseline test and computer attitude and digital self-efficacy scales. Twenty-four percent of the total enrolment of first year students in 2013 and 2014 completed the online questionnaire. While 307 students was a fair number, a researcher always hopes for maximum participation. My results reflected only the students who were willing to complete the online questionnaire and be interviewed. As a result, all the first year pre-service teachers were not accurately represented. A hurdle I did not anticipate was the changing of the course content, organization and baseline test from 2013 to 2014. This was not a scenario that I expected and

was not ideal for consistency. Unfortunately, this was beyond my control and I accounted for this factor in my methodology chapter.

My analysis of the students' learning networks was a subjective one. As the researcher, I decided where to "cut the line" when presenting the students' learning networks. These learning networks were only real in the moment that I analysed them and would have since changed. My encounters with the students also had an impact. I would have featured as a node in their network of learning. It was also difficult to pioneer my application of ANT as I had no other research projects to follow to confirm that I was on track. The more I delved into ANT, the more I realised how broad and deep it is. The resource I drew on was Fenwick and Edwards, 2010, book on Actor-Network in Education to assist me in responsible and accurate application of ANT to my research. Dzakiria recommends that one of the requirements that ANT driven research should meet is the acknowledgement that ANT is a boundaryless and holistic approach and context as such does not exist. The researcher should establish a divide between nodes that leave traces and nodes that do not leave traces. These nodes that leave traces really exist and are focused on (Dzakiria, 2006). ANT asks researchers to determine what is present and what is creating an actor. It is possible that there is a mainly human involvement in shaping that specific actor-network or vice versa. The important thing is not to pre-determine who or what is involved in the creation of the actor-network. Rather, all potential actors should be treated from an equal starting point (Banks, 2011). I identified and linked all the explicit nodes in each of the six students' learning networks to establish commonalities and differences in them. I was conscious of not making any assumptions as to possible nodes in the networks. I documented as closely as possible the actual nodes or agents the students identified in answering the questions I posed about their learning in the online questionnaire. When everything goes according to the plan, students will develop a desired level of digital competence. However, certain factors impact on this process. Because some of the identified actors or nodes in the network could not talk, I used interviews with human actors involved in the project to gather the data. After the fieldwork and collection of rich data that was produced it was difficult to choose what was useful to the research and what was not. This is where I returned to my research questions and own personal pre-conceived hypotheses. I wanted to describe the students' learning experiences. I wanted to give each student a voice and present each student's unique story. Using ANT as an analytical framework assisted me in extracting the key nodes of each

network. Delving even further into the actual node components showed the way in which the nodes came together to contribute to the student's learning.

Dzakiria cautions against using ANT, because although it can result in surprising conclusions, there is no guarantee that this will be the case. It is well suited for exploratory research such as mine and can be used as a research method to go into complex issues that cannot be understand through the use of traditional theories and methods. Due to its boundarylessness, it is possible that ANT driven research can produce new and unexpected conclusions (Dzakiria, 2006). He also cautions against the use of statistical data to generalise conclusions. Therefore, while I provide descriptions of six students' networks of learning, I acknowledge that the findings from an analysis of these cannot be generalised to all students' networks of learning to be digitally competent.

9.4. Limitations

I identified five possible limitations to my study. Firstly, my research was conducted in a very specific context. I investigated the phenomenon of developing digital competence in a group of first year pre-service teaching students at a South African HEI in 2013 and 2014. Due to the characteristics of the sample in my study, caution must be used when interpreting the results. The second limitation I address below is my own framework of meaning-making and the possible influence my own assumptions and hypotheses about my research may have had on the research findings. Thirdly, I had to rely on the baseline digital competence test provided as a means to establish the students' digital competence levels. The fourth limitation was that I only explored the learning networks of six students in chapter eight. The final limitation is the presence that I as a human actor may have had on the students' networks of learning in the moments that I engaged with them during my research and interviews.

The first limitation of my study is the specific context of my research. It is not only location and population specific but also time specific. My research took place in the pre-service teaching students first year of study at the HEI during 2013 and 2014. Students in South Africa are unique in many ways and Higher Education institutions register students with a range of demographic characteristics. It is also possible in the years that followed 2014, high school curricula could have addressed some of the raised concerns and subsequent first year students entered the HEI more digitally competent than their predecessors. As a result of the specific context of my research, findings are only relevant or relatable internally within the

HEI or externally to other pre-service teaching students at other HEI institutions. As Dzakiria advises, the power of extending the internal to external generalisation is not within the reach of any researchers. However, the reader possesses this power as they know best on which research and findings are related or usable to them. The reader can make generalisations based on the premise of relatability (Dzakiria, 2006).

The second limitation is that my own framework of meaning making influenced the emphasis I paid to certain nodes within my own network of learning in the way I interpreted and documented my research findings. As proposed earlier in this thesis, I used an interpretivist framework. Such a framework follows the premise that knowledge is constructed not only by observable phenomena, but also by descriptions of people's intentions, beliefs, values and reasons, meaning making and self-understanding (Henning, et al., 2004). I relied on the students own meaning-making in their descriptions of their learning. I also began the study with my own pre-conceived assumptions and these may have initially impacted on the direction of the study itself. At the onset of my research project, I assumed that students with a high computer attitude (CA) or level of digital self-efficacy (DSE) or both may be more digitally competent and were likely to have passed the initial baseline digital competence test. In addition to this, I made the assumption that students with a high CA or DSE or both were more likely to achieve the desired level of digital competence within a shorter timespan than students with a low DSE or CA or both. In hindsight, these were strong assumptions to make. Who was I to decide what was a teaching – learning context? How could I proclaim that a student may not develop greater digitally competence when actually teaching in a school situation regardless of the level of digital competence they graduated with. I realised that it may not be necessary for the students to graduate at the proposed adoption phase level. After examining the multitudes of ways in which students become digitally competent, I now question how much influence the ICT Guideline document should have? It is obvious that HEIs should strive to develop certain competences in the students, or at least present them with reasonable opportunity to. The possibility exists that the students may learn more from their friends and peers in a just-in-time scenario than in a just-in-case set-up in a formal classroom situation.

The third limitation of my study was that it did not evaluate the effectiveness of the first year digital competence course on the development of digital competence in the first year pre-service teaching students. This may prove an interesting avenue to pursue in future research.

I was also limited in my use of the baseline assessment that was currently used in the first year ICT course in the two years in which I gathered my data.

In chapter eight, I addressed research question four, searching for a commonality in the way students come to be digitally competent. Using both the quantitative and qualitative data I collected, I expanded and presented the components of the nodes interacting in the learning networks of six phase two students. Only detailing six students out of a possible 28 may be a fourth limitation and I acknowledge that a deeper exploration of the data and more interviewed students is likely to produce interesting and possibly unpredictable results.

Finally, as a researcher applying an ANT analysis, I acknowledge that I myself as the researcher impacted on the student's learning network. This could have been my own actual physical presence as a human node or actor within the student's learning network. My hypotheses and preconceived notions and interests in what was important to study directed me to concentrate on particular issues and nodes within a learning network whereas a different researcher with a different agenda may have cut the network differently and focused on different nodes.

9.5. Implications for future practice and directions for future research

It is not unreasonable, in our e-permeated society to think of digital competence as a basic skill needed to function in society (Gilster, 1997), as an essential requirement for life (Bawden, 2008), or even as a survival skill (Eshet-Alkalai, 2004). Literature and surveys warn against the inadequate digital competence levels of both the younger (Newman, 2008) and the older population (Ferrari, 2012). My research shows low levels of digital competence in the first year pre-service teaching student population entering the HEI in 2013 and 2014. In the introduction I point out that a teacher is expected to qualify from a tertiary institution possessing a certain degree of digital skills. Qualitative studies such as mine can provide detailed descriptions and analyses of particular practices, processes or events (McMillan & Schumacher, 2006). In my study the description is that of coming to be digitally competent. The identification of, and investigation into the possible factors impacting on a first year pre-service teaching student's development of digital competence better assists such institutions and course designers to alleviate the possible barriers and increase the enablers.

9.5.1. Contribution

Roth and McGinn argue that ANT is important for teaching-learning research as well as instructional practice precisely for its challenge to narratives of certainty. ANT helps educators and students examine their multivocality and the precarious connections among things and people. ANT unpicks the apparent black boxes of much curricular knowledge and educational practice, and offers resources to trace the many webs and players and non-coherences embedded in them (Roth & McGinn, 1997). My study contributes to knowledge in four ways. Firstly, I establish the digital competence skills of first year pre-service teaching students. Secondly, I identify the barriers first year pre-service students encountered when using ICTs. Thirdly, I look at the possible impact of computer attitude and digital self-efficacy on the development of digital competence. Finally, I detail the networks of learning to be digitally competent. Through this expansion of students' networks of learning, the connections between the various nodes and actants at work become apparent. This gives readers insight into what nodes are at play within these networks and what the pre-service teaching students identify as significant in their learning.

9.5.1.1. Establishment of digital competence skills of first year pre-service teaching students

My research found that first year pre-service teaching students entering the HEI did not possess the necessary digital competence skills. Forty-three percent of the students did not pass the baseline digital competence test. I investigated the possible contributing factors to this low level of basic digital competence.

9.5.1.2. Barriers first year pre-service teaching students encountered

Brown and Czerniewicz suggest by redefining the concept of digital skills to extend beyond digital haves or digital have-nots, many more students would be able to be more accurately positioned in relation to their actual digitally-mediated experiences. Their research makes it clear that students classified as outsiders because of age or lack of digital experience still possess digital skills. I found this to be true in my research. Even the novice and beginner students had some digital experience. While I acknowledge the digital elites and advanced ICT users, my research focuses on the reasons why students did not succeed in developing digital competence. As mentioned in the introduction to this chapter, Czerniewicz and Brown's concept of "digitizens" allows for notions of access as being determined by connectivity and not location, and the acknowledgement of skills based on what students are

able to achieve rather than the mastery of a device. Czerniewicz and Brown acknowledge that this poses new challenges for students and educators alike. Findings from my research support their view that course designers should design for increased diversity and new practices. Mobile phones should also be seen as primary devices or locations of learning. A rigorous conception of emerging digital practices coupled with expert knowledge of learning design might make the possibility of a digital democracy in higher education a reality (Brown & Czerniewicz, 2007).

9.5.1.3. Impact of computer attitude and digital self-efficacy on the development of digital competence

The most notable finding from my research is contrary to other studies and literature. I found, in the context of my study, that digital self-efficacy rather than computer attitude to be a more notable determiner of possible success with digital devices and impacting on the development of digital competence. These findings may be relatable to other research populations similar to the first year pre-service teaching students that participated in my research. My study contributes to the research Czerniewicz and colleagues from the University of Cape Town (UCT) conducted into ICTs and their use in South African HEIs by providing more detailed findings on the impact of attitude and self-efficacy in the development of digital competence in first year pre-service teaching students. Brown and Czerniewicz's research findings show that within the South African students they sampled there was a small group of elite students who share the basic characteristics of the digital native. However they point out that the classification of this group was based on simplistic criteria that only encapsulated the students' access to and skills in using technology. It did not examine the extent and depth of their technology use nor the choices they made about this use (Brown & Czerniewicz 2007). Czerniewicz and Brown question the concept of the digital native as students have more complicated identities and engage in a digital world in far more complex and heterogeneous ways. My research findings elucidate this notion of complicated individuals interacting with digital devices in a complex manner. The vast discrepancy in student results in the baseline test, the barriers and enablers they identified point to uniqueness in their experiences in addition to the identified multitude of actors or nodes interacting in their networks of learning to be digitally competent.

9.5.1.4. Networks of learning to be digitally competent

Following on from this, I feel a contribution to research in the field of the development of digital competence in first year pre-service teaching students is my application of ANT in analysing their learning networks. Advancing on Barab, et al.'s (2001) node components, I identify important nodes in the students' networks of learning and successfully map these. I open the black box and make explicit the relevant nodes – both the human and non-human actors that come into play, and their possible involvement in the student's development of digital competence.

9.5.2. Recommendations

The key findings of my research and possible recommendations are presented in table 50 below. My study shows an individual's computer attitude is not a key influencer in digital success (section 7.1.2.1.) while digital self-efficacy is (section 7.2.2.1.). I propose recommendations in response to the findings of each research question in table 50 above. The dominant recommendation is that a first year digital competence or ICT course is necessary for first year pre-service teaching students at the HEI. Wu and Tsai found in their 2006 study involving 1 313 university students in Taiwan that students' attitudes toward the Internet and their Internet self-efficacy were highly related. They proposed that training programmes or courses may be helpful to improve university students' Internet attitudes and self-efficacy (Wu & Tsai, 2006). A similar study was conducted by Torkzadeh and Van Dyke in 2002, with 189 American university students. Results suggest that training significantly improved Internet self-efficacy and individuals with 'high' and 'low' attitudes toward computers seem to equally benefit from training programmes. Similar to my research findings, individuals with a high attitude toward computers had higher self-efficacy scores than individuals with a low attitude toward computers. They found that training programmes did not seem to influence attitudes toward computer usage (Torkzadeh & Van Dyke, 2002). As I show in table 50 below, the finding to research question 3b shows that digital self-efficacy is a strong determiner of digital success. While the above two studies were conducted into Internet self-efficacy, I argue that their findings are relatable to mine in the area of digital self-efficacy because effective use of the Internet is a large component of digital competence as shown in table 1 earlier in this thesis.

Table 50: Recommendations based on research findings

	Research questions	Answers to research questions	Recommendations
1	What are first year first year pre-service teaching students' perceptions of digital competence?	Digital competence is a functional skill.	Ensure a course design meets these perceptions or the students will not see it as worthwhile. However, ensure they are exposed to the other important components of digital competence as detailed in table 1.
2	What are first year pre-service teaching students' current levels of digital competence?	Digital competence skills are low as only 43% passed the baseline digital competence test.	A digital competence course is essential for first year pre-service teaching students at the HEI. Course designers should establish which skills the students are lacking in and design courses to address the students' immediate needs.
3	What factors inhibit or afford the development of the first year pre-service teaching student's digital competence?	Barriers: • Inexperience • Access • User-unfriendliness of software	Acknowledge that not all students have the same experience with ICTs prior to enrolment at the HEI. Provide optimal access to ICTs on campus and investigate a laptop for students initiative. Ensure software used in digital competence courses is relevant and accessible.
3	What factors inhibit or afford the development of the first year pre-service teaching student's digital competence?	Enablers: • Previous experience • Access • User-friendliness of software • Support	Establish students' prior experience with ICTs and build on this. Provide adequate access to ICTs on campus. Ensure course software is relevant and accessible. Make support easily available in the form of relevant course material, tutor support and student computer laboratory assistants.
3a	What relationship is there (if any) between computer attitude and a student's attainment of digital competence?	There is no correlation between computer attitude and a student's digital competence.	As computer attitude and digital self-efficacy are statistically correlated, it is advantageous to investigate ways to promote computer attitude as this ultimately impacts on a student's digital self-efficacy level.
3b	What role does a belief in one's own ability to use ICTs (self-efficacy) play in the development of digital competence?	A strong belief in one's own ability was found to be a strong determiner in learning to be digitally competent.	Investigate ways in which a student's digital self-efficacy levels can be enhanced. This could entail a research project of its own. Some recommendations follow this table in the discussion below.
3b	What role does a belief in one's own ability to use ICTs (self-efficacy) play in the development of digital competence?	First year pre-service teaching students want to improve their digital competence skills.	Afford students this opportunity by providing a first year digital competence course at the HEI.

	Research questions	Answers to research questions	Recommendations
4	How do first year pre-service teaching students come to be digitally competent?	Various actors come into play in a student's network of learning to become digitally competent.	Acknowledgement of the myriad of human and non-human actors that come into play in a student's network of learning to become digitally competent. Should depunctualisation occur, open the black box to investigate the network and identify possible issues.

In conducting this research and analysing the findings, I show a first year digital competence or ICT course for pre-service teaching students at the HEI remains a necessity. As discussed in section 2.3., Koutropoulos (2011) cautions against assuming that young students have already grown in areas that they so clearly have not. Czerniewicz is also against making assumptions that all students are digitally competent. Findings from her studies showed that access was a more discerning factor than age (Brown & Czerniewicz, 2010; Czerniewicz & Brown, 2010). It would be beneficial if this ICT course had a just-in-time focus with some basic just-in-case skills to promote the novice and beginner students' confidence and belief in their own ability to promote future success. It would be interesting to investigate how the students who initially failed the baseline test are faring later in their studies. Further investigation into whether the baseline test is a good indicator of a student's actual ability and possible predictor of future success would be a suitable follow-up study to pursue.

As the majority of students surveyed indicated relying on themselves, a strong belief in their own ability is important. The students wanted to improve their digital competence skills due to their current limited knowledge. In further research, course designers could establish which skills the students are lacking in and design courses to address the students' immediate needs. While I establish the necessity for a first year digital competence course, further research into the composition of such a course is indicated. I am cognisant that research cannot easily impose change on others, but argue that my research helps suggest or negotiate for improvements within the research setting (Dzakiria, 2006). The HEI should meet the requirement of providing digitally competent graduating teachers. The result of an analysis of the six learning networks shows more differences (over 16) than commonalities. It took me a long time to acknowledge that this is an acceptable finding. Having initially set out to

document a step by step procedure for students to follow to guarantee their development of digital competence, I discovered that too many unique and powerful nodes came into play in a learning network.

9.6. Final statement

In the introduction to my thesis, I noted the Guidelines for Training and Professional Development in ICT's call for students to have the knowledge, skills and support necessary to integrate ICT into teaching and learning. The pre-service teaching students were expected to graduate from the HEI with a required level of digital competence. My research project looked at the levels of digital competence of the first year pre-service teaching students entering a particular HEI. I also established what they understood digital competence to be, the barriers they encountered and the influence of their attitude and self-efficacy on their development of digital competence. I noticed that students came to be digitally competent in a myriad of ways and their unique learning networks comprised of varying nodes and actants. While certain nodes were comparable to the majority of students, the negotiations between these were influenced in varied ways. Addressing the title of my research project, although literature and other studies found computer attitude influenced digital competence development, my research showed in the context of my study that digital self-efficacy rather than attitude to be a more notable determiner of possible success.

I conclude with a statement made by 22 year old Nona in her interview. I found her statement presented good advice for any student embarking on a learning process, including myself in my journey as a PhD student. She said, "*If you do not put yourself out there, you are always going to remain in your little shell. So you need to get out there. I mean you get better. I am telling you, trust me. You just get better and better, and before you know it, you are better than some other people and you are like – what? She does not know that and I know that!"*

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Appendix A

First year questionnaire

I understand that I do not have to complete this questionnaire.

Signed:_____

I understand that the information from this questionnaire is confidential and will only be used by the researcher. My name will not be revealed to anyone other than the researcher

Please complete this questionnaire as truthfully as possible. The answers you put will have no impact on your course marks and are only used for research purposes.

Please tick the relevant boxes and fill in information in the spaces provided. If you do not wish to answer a question, please leave it blank.

Name _____ Age _____

Gender Male | Female What year did you matriculate in: _____

Languages:

What language do you speak at home?

☐ Sepedi ☐ Sesotho ☐ Siswati ☐ Tshivenda

☐ Xitsonga ☐ Afrikaans ☐ English ☐ isiNdebele

☐ isiZulu ☐ isiXhosa Other _____

What other languages do you speak?

☐ Sepedi ☐ Sesotho ☐ Siswati ☐ Tshivenda

☐ Xitsonga ☐ Afrikaans ☐ English ☐ isiNdebele

☐ isiZulu ☐ isiXhosa Other _____

Access to ICTS:

You may tick more than 1 box. Please add any other device you own that is not mentioned here in the empty spaces

Do you own a

Desktop computer	laptop	Tablet device like an ipad	Cellphone without Internet access	Cellphone that can access the Internet
Kindle	Xbox, Wii	ipod	ipod touch	

Digital Literacy

What do you understand the term digital literacy to mean?

Tick only the box that best describes yourself:

I have never used a computer before	Beginner computer user	Intermediate computer user	Advanced computer user

Tick only the box that best describes yourself:

I have never used the Internet before	Beginner Internet user	I can find the information I need without too much difficulty	Intermediate Internet user	Advanced Internet user

Tick only the box that best describes yourself:

I do not have a cell phone	I use my cell only to make calls	I use my cellphone to make calls and send smses	I use my cellphone to make calls, send smses and find information on the Internet	I use my cellphone to make calls, send smses, find information on the Internet, do online banking, download music etc

What do you else do you use your cellphone for?

Do you want to become digitally literate?

No	Maybe	Yes

Why did you answer yes, no or maybe above?

Who will teach you to become digitally literate?

What are you using to help yourself become digitally literate?

Factors:

What makes it difficult for you to use a digital device such as a laptop, cellphone?

What makes it easy for you to use a digital device such as a laptop, cellphone?

Thank you for your time and assistance

Appendix B

Loyd and Gressard Computer Attitude Scale (CAS) (Farkas & Murthy, 2005)

Below are a series of statements. There are no correct answers to these statements. They are designed to permit you to indicate the extent to which you agree or disagree with the ideas expressed. Place a checkmark under the label which is closest to your agreement or disagreement with the statements.

		Strongly agree	**Slightly agree**	**Slightly disagree**	**Strongly disagree**
1	Computers do not scare me at all				
2	I'm no good with computers				
3	I would like working with computers				
4	I will use computers many ways in my life				
5	Working with a computer would make me very nervous				
6	Generally, I would feel OK about trying a new problem on the computer				
7	The challenge of solving problems with computers does not appeal to me				
8	Learning about computers is a waste of time				
9	I do not feel threatened when others talk about computers				
10	I do not think I would do advanced computer work				
11	I think working with computers would be enjoyable and stimulating				
12	Learning about computers is worthwhile				
13	I feel aggressive and hostile toward computers				
14	I am sure I could do work with computers				
15	Figuring out computer problems does not appeal to me				
16	I'll need a firm mastery of computers for my future work				
17	It wouldn't bother me at all to take computer courses				
18	I'm not the type to do well with computers				
19	When there is a problem with a computer run that I can't immediately solve, I would stick with it until I have the answer				
20	I expect to have little use for computers in my daily life				
21	Computers make me feel uncomfortable				
22	I am sure I could learn a computer language				
23	I don't understand how some people can spend so much time working with computers and seem to enjoy it				
24	I can't think of any way that I will use computers in my career				
25	I would feel at ease in a computer class				
26	I think using a computer would be very hard				
27	Once I start working with the computer, I would find it hard to stop				
28	Knowing how to work with computers will increase my job possibilities				
29	I get a sinking feeling when I think of trying to use a computer				
30	I could get good grades in computer courses				
31	I will do as little work with computers as possible				
32	Anything that a computer can be used for, I can do just as well some other way				
33	I would feel comfortable working with a computer				
34	I do not think I could handle a computer course				
35	If a problem is left unsolved in a computer class, I would continue to think about it afterward				
36	It is important to me to do well in computer classes				
37	Computers make me feel uneasy and confused				
38	I have a lot of self-confidence when it comes to working with computers				
39	I do not enjoy talking with others about computers				
40	Working with computers will not be important to me in my life's work				

Appendix C

The Murphy (1989) Computer Self-efficacy Scale (Khorrami-Arani, 2001)

Below are a series of statements. There are no correct answers to these statements. They are designed to permit you to indicate the extent to which you agree or disagree with the ideas expressed. Place a checkmark under the label which is closest to your agreement or disagreement with the statements.

Statement	Strongly agree	Slightly agree	Neutral	Slightly disagree	Strongly disagree
I feel confident working on a personal computer					
I feel confident getting the software up and running					
I feel confident entering and saving data (numbers or words) into a file					
I feel confident escaping / exiting from a program or software					
I feel confident choosing a data file to view on a monitor screen					
I feel confident handling a usb correctly					
I feel confident making selections from an onscreen menu					
I feel confident using a printer to make a "hard copy" of my work					
I feel confident copying a disk					
I feel confident copying and individual file					
I feel confident adding and deleting information to and from a data file					
I feel confident moving the cursor around the monitor screen					
I feel confident using the computer to write a letter or essay					
I feel confident storing software correctly					
I feel confident getting rid of files when they are no longer needed					
I feel confident organising and managing files					
I feel confident using the user's guide when help is needed					
I feel confident understanding terms / words related to computer hardware					
I feel confident understanding terms / words relating to computer software					
I feel confident learning to use a variety of programs (software)					
I feel confident learning advanced skills within a specific program (software)					
I feel confident using the computer to analyse number data					
I feel confident writing simple programs for the computer					
I feel confident describing the function of computer hardware (keyboard, monitor, disk drives, processing unit)					
I feel confident understanding the three stages of data processing: input, processing, output					
I feel confident getting help for problems in the computer system					
I feel confident explaining why a program (software) will or will not run					
I feel confident using the computer to organise information					
I feel confident troubleshooting computer problems					
I feel confident logging onto a mainframe computer system					
I feel confident working on a mainframe computer					
I feel confident logging off the mainframe computer system					

Appendix D

Newspaper article

State sends teachers back to school

PIET RAMPEDI

THE Limpopo education department has taken an unusual step in a bid to improve the future standard of education in the province.

It has withdrawn 322 teachers on full pay and sent them on a four-year government funded specialised training programme at the universities of the Witwatersrand and KwaZulu-Natal – to the tune of R33 million.

Education MEC Aaron Motsoaledi said the initiative came after an evaluation of Grade 3 learners over the past few years showed a lack of teaching skills at the foundation phase. This phase is critical and covers grades one to three.

He said the future of foundation phase learners in Limpopo remained in the hands of underqualified teachers with few skills and this resulted in learners being more vulnerable, Motsoaledi said.

"The learners can easily be destroyed if you put poorly qualified teachers before them. They absorb everything and they can be made to like or dislike books," he said.

As part of a contract signed with the department, the teachers have to work in Limpopo public schools for five years once they qualify, or refund the department for all expenses incurred.

Motsoaledi said the programme would continue for the next decade with at least 100 bursaries offered yearly.

Mary Metcalfe, the director of Wits University School of Education, said the curriculum for the four-year foundation phase degree included academic and professional components. Among others, students were taught the methodology of teaching foundation phase, especially numeracy and literacy.

Metcalfe said the new intakes would also spend six weeks every year in township and former model C schools to garner different experiences.

She blamed the shortage of foundation-phase teachers for South Africa's declining education standard.

The downward spiral in matric results has culminated in the national pass rate dropping to 62.5% last year.

"Foundation phase is the basis for excellence and the basis for the future," Metcalfe insisted.

Metcalfe added that Limpopo's long-term investment was necessary because there was no "quick fix" for the problem.

Molatelo Mothiba from Ga-Matlala near Mokopane, a foundation-phase teacher since 1994, said she was ready for the new challenge.

"I am excited. I will come back well-equipped because I have been trying to teach foundation phase without success due to my limited knowledge," she said.

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Appendix E

Interview Schedule

I will cover the following in a congenial manner:

1. I will first warmly thank the participant for being willing to be interviewed and for giving of their time.
I have invited you to participate in this interview because I found some of the comments that you made on the questionnaire really interesting. I would like to have an opportunity to hear more about your opinions and experiences using ICTs.

2. I will explain that I am using a voice recorder to capture the interview.
I will be using a recorder so that I am able to have more of a discussion with you rather than having to take notes. I will keep your name confidential and all recordings will be destroyed after I have transcribed / written down our conversation.

3. I will go through the whole information letter, drawing particular attention to the following:
   - · The student may withdraw at any time.
   - · His/her name will be kept confidential (i.e. known only to me) but I may anonymously quote the things s/he says.
   - · I will destroy all audio tapes after transcribing.

4. I will ask whether s/he has any questions.
I have a couple of specific questions I would like to ask you relating to some of the questions you already answered in the questionnaire. I am also interested in any additional comments you would like to make. Please feel free to raise any further issues that you may find relevant as we go along. You are also welcome to ask me any question and if you do not understand a question, I will clarify it for you.

5. I will then ask the student if they are willing to sign the interview and audio-recording consent forms. At this point I will again remind him/her that s/he is not obliged to participate, and may withdraw at any time.
If I ask you a question that you do not wish to answer, simply say "next question", and I will move on. If you want to end the interview at any point, you can let me know and we will stop.

6. I will ensure that the student understands what I mean by the term ICTs. I will have samples / pictures of the ICTs I will discuss with them.
Ipad / tablet, Laptop, Desktop computer, Kindle, Ipod touch, mobile phone, Xbox, Wii

1. Describe your experience with a computer? (How often do you use it and for what purpose)
2. Is this the first time you have used a computer – why haven't you used one before?
3. Are you forced by others to improve your ICT skills? Who?
4. What makes it hard for you to use ICTs?
5. How do you feel when using ICTs? Describe your emotions.
6. Are you teaching anyone how to use computers?
7. Has your initial feeling towards using ICTs changed?
8. How have you come to be digital literate?
9. Are your Internet skills better than your computer skills? (If yes, why?)
10. Questions relating to results
    Does having a positive attitude / belief in your own ability make it easier for you to become dig lit?
11. Are you attending the ICT lectures at the HEI? If not, why?
12. If you are attending these lectures, are they helping you?
13. How do you feel about your own ability to use a computer?
14. Have your ICT skills improved since you arrived at the HEI? What can you do now that you could not do before?

<u>Conclusion</u>

- Do you have any questions or comments for me?
- Would you like to return to any of your comments and elaborate, explain or withdraw them?

I will thank the student for participating and ask them if they will be available for a follow-up interview at a later stage.
Thank you for your time, I really appreciate it. Would it be ok if I contacted you in a month or two to find out how things are going with your ICT usage?

Appendix F

Follow-up Interview Schedule

I will cover the following in a congenial manner:

1. I will first warmly thank the participant for being willing to be interviewed again.
Thank you for once again for agreeing to this interview. I would like to follow-up with some questions based on the last interview we had.

2. I will explain that I am using a voice recorder to capture the interview.
I will be using a recorder so that I am able to have more of a discussion with you rather than having to take notes. I will keep your name confidential and all recordings will be destroyed after I have transcribed / written down our conversation.

3. I will go through the whole information letter, drawing particular attention to the following:
   - The student may withdraw at any time.
   - His/her name will be kept confidential (i.e. known only to me) but I may anonymously quote the things s/he says.
   - I will destroy all audio tapes after transcribing.

4. I will ask whether s/he has any questions.
I have a couple of specific questions I would like to ask you relating to some of the questions you already answered in the questionnaire and in your last interview. I am also interested in any additional comments you would like to make. Please feel free to raise any further issues that you may find relevant as we go along. You are also welcome to ask me any question and if you do not understand a question, I will clarify it for you.

5. I will then ask the student if they are willing to sign the interview and audio-recording consent forms. At this point I will again remind him/her that s/he is not obliged to participate, and may withdraw at any time.
If I ask you a question that you do not wish to answer, simply say "next question", and I will move on. If you want to end the interview at any point, you can let me know and we will stop.

1. Do you feel more confident using ICTs than you did last year?
2. You mentioned X being a barrier to your effective use of ICTs. Is this still the case? Is there any new factor that makes it difficult for you to use ICTs?
3. You rated yourself as a (novice, beginner, intermediate, advanced) computer user. Is this still the case?
4. What advice would you give to a first year pre-service teaching student entering the HEI who has never used a computer before?
5. Can you tell me in five steps how you came to be digitally literate?

<u>Conclusion</u>
- Do you have any questions or comments for me?
- Would you like to return to any of your comments and elaborate, explain or withdraw them?

I will thank the student for participating.
Thank you for your time, I really appreciate it.

Appendix G

Dear first year B Ed student.
You are being invited to take part in a research study as part of a student project. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information.

Who will conduct the research?
Claudette Muller, PhD student at the Wits School of Education

Title of the Research
The development of digital literacy in pre-service teachers

What is the aim of the research?
I aim to find out what barriers students face when they use digital devices such as computers, mobile phones, ipads, laptops etc. I want to establish the ways in which first year students come to be digitally literate.

Why have you been chosen?
All first year B Ed students will be asked to complete 2 assessments to establish:

- *Their attitude towards using information and communication technologies (ICTs) such as computers, mobile phones etc.*
- *Their Digital Self-Efficacy, or belief in their own ability to use ICTs.*

What happens to the data collected?
I will analyse the data in an attempt to establish patterns about the ways in which students come to be digitally literate. I will also look to see if students experience common barriers in their use of digital devices.

How is confidentiality maintained?
Pseudonyms will be used when I report back the findings in my study. I can guarantee you that you will not be identified in any way.

What happens if you do not want to take part or if you change my mind?
It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time without giving a reason and without detriment to yourself

Where will the research be conducted?
The research will be conducted at the HEI during your New Literacies or Digital Literacy lectures.

Will the outcomes of the research be published?
The findings from this research will be used for my final PhD thesis. Papers may be written from this thesis and published in educational journals.

Contact for further information
Claudette Muller
muller_claudette@yahoo.com
082 xxx 8736

Appendix H

Title of the project: *The development of digital literacy in pre-service teachers.*

Researcher's contact details: *Claudette Muller*
muller_claudette@yahoo.com
082 XXX 8736

I agree to take part in the above research. I have read the Participant Information Sheet, which is attached to this form. I understand what my role will be in this research, and all my questions have been answered to my satisfaction.

I understand that I am free to withdraw from the research at any time, for any reason and without prejudice.

I have been informed that the confidentiality of the information I provide will be safeguarded.

I am free to ask any questions at any time before and during the study.

I have been provided with a copy of this form and the Participant Information Sheet.

Name of participant

(print)…….Signed……..….Date……

Appendix I

Title of the project: *The development of digital literacy in pre-service teachers.*

Researcher's contact details: *Claudette Muller*
muller_claudette@yahoo.com
082 XXX 8736

I agree to take part in the above research. I have read the Participant Information Sheet, which is attached to this form. I understand what my role will be in this research, and all my questions have been answered to my satisfaction.

I understand that I am free to withdraw from the research at any time, for any reason and without prejudice.

I have been informed that the confidentiality of the information I provide will be safeguarded.

I am free to ask any questions at any time before and during the study.

I have been provided with a copy of this form and the Participant Information Sheet.

I am aware that I will be interviewed by the researcher. The interview will take 10-15 minutes of my time and will be conducted on the HEI campus.

I am aware that the interviews that I have with the researcher will be **audio recorded** in order to ensure accuracy.

I am aware that the researcher will also make written notes of my responses to questions posed in the interview.

I understand that pseudonyms will be used to protect my anonymity.

I consent / do not consent to the information I provide to be used in the above study. (Delete what does not apply)

Name of participant

(print)…….Signed……..….Date……

Appendix J

Phase 2
Participant Consent Form
Audiotaping

Title of the project: *The development of digital literacy in pre-service teachers.*

Researcher's contact details: *Claudette Muller*
muller_claudette@yahoo.com
082 XXX 8736

I agree to take part in the above research. I have read the Participant Information Sheet, which is attached to this form. I understand what my role will be in this research, and all my questions have been answered to my satisfaction.

I understand that I am free to withdraw from the research at any time, for any reason and without prejudice.

I have been informed that the confidentiality of the information I provide will be safeguarded.

I am free to ask any questions at any time before and during the study.

I have been provided with a copy of this form and the Participant Information Sheet.

I am aware that I will be interviewed by the researcher. The interview will take 10 – 15 minutes of my time and will be conducted on the HEI campus.

I give my consent for the interviews that I have with the researcher to be **audio recorded** in order to ensure accuracy.

I am aware that the researcher will also make written notes of my responses to questions posed in the interview.

I understand that pseudonyms will be used to protect my anonymity.

I consent / do not consent to the interview to be audio-recorded. (Delete what does not apply)

Name of participant

(print)…….Signed……..….Date……

Appendix K

Ethics clearance protocol number

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3064 Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

Student Number:

Protocol Number:
2012ECE052

Date: 03-Jun-2012

Dear Claudette Muller

Application for Ethics Clearance:

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate has considered your application for ethics clearance for your proposal entitled:

The development of digital literacy in pre-service teachers

The committee recently met and I am pleased to inform you that clearance was granted. The committee was delighted about the ways in which you have taken care of and given consideration to the ethical dimensions of your research project. Congratulations to you and your supervisor!

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely

M Mabeta

Matsie Mabeta
Wits School of Education

011 717 3416