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Factors affecting teachers' use of computer technology for promoting meaningful learning

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Chapter 3

Research design and methods for investigating the factors affecting teachers' use of ICT (Phase 1)

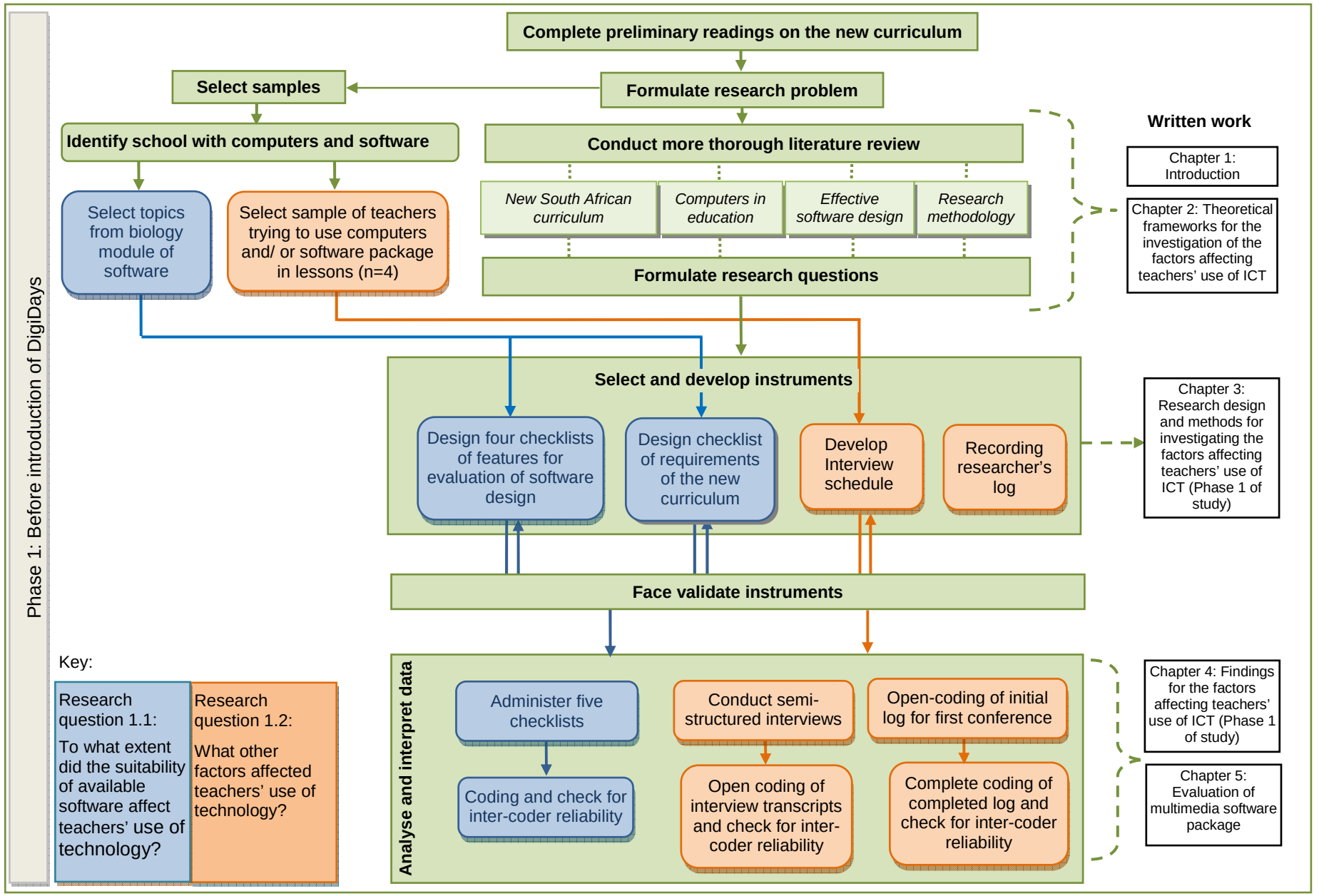
The first section of this chapter deals with general design issues for the study as a whole. The rest of the chapter relates to the design and methods used during Phase 1 and Phase 2 of the study to investigate factors affecting teachers' use of ICT. I also report on the methods used to improve rigour, and on the ethical considerations for the study.

3.1 GENERAL ISSUES RELATING TO THE RESEARCH DESIGN OF THE WHOLE STUDY

3.1.1 Research design

Research has been defined as the "*process of arriving at dependable solutions to problems through the planned and systematic collection, analysis and interpretation of data*" (Mouly, 1978, as cited in Cohen & Manion, 1980, p. 29). The use of the words "*planning"* and "*systematic"* suggest that research should not be conducted in a haphazard fashion, but rather that it should follow a definite "*plan of action*" (LeCompte & Schensul, 1999, p. 61). In any study, the search for answers to research questions is best served by having a blueprint which can be used to guide researchers through the research process by outlining how a study is to be organised and conducted (LeCompte & Schensul, 1999). Such a blueprint for the research is referred to as the 'research design'. Designing the research carefully, with forethought, allows researchers to anticipate fundamental issues around the collection and interpretation of data, such as the type of data needed to answer the research questions, where the data will be found, how the data will be obtained and how the data will be interpreted (Leedy, 1993).

Figure 22 is a summary of the research design used in this case study. It shows the different stages (e.g. data collection and data analysis), with the vertical axis of the figure representing the chronological order in which the various stages were conducted. The study is divided into two phases (see Figure 22). The first phase (before the innovation promoting the use of digital technology was introduced at the school) began with an evaluation of a multimedia software package for use within the context of a new curriculum (see blue boxes in Figure 22) and was subsequently expanded into an investigation of factors other than software quality affecting teachers' use of ICT (see orange boxes in Figure 22). The investigation into factors affecting teachers' use of ICT continued into the second phase of the study (after the innovation was introduced), since the innovation allowed certain factors to be explored more deeply. This chapter deals with the methods of data collection and analysis for the overarching aim of the study: the investigation of factors within the school which could affect teachers' use of the software package as support material for teachers implementing a new curriculum. The methods relating to the software evaluation conducted as part of the investigation of the impact of software quality on teachers' use of technology are dealt with in Chapter 5.


Phase 1: Before introduction of DigiDays
Complete preliminary readings on the new curriculum
Formulate research problem
Select samples
Identify school with computers and software
Select topics from biology module of software
Select sample of teachers trying to use computers and/ or software package in lessons (n=4)
Conduct more thorough literature review
New South African curriculum
Computers in education
Effective software design
Research methodology
Formulate research questions
Written work
Chapter 1: Introduction
Chapter 2: Theoretical frameworks for the investigation of the factors affecting teachers' use of ICT
Select and develop instruments
Design four checklists of features for evaluation of software design
Design checklist of requirements of the new curriculum
Develop Interview schedule
Recording researcher's log
Chapter 3: Research design and methods for investigating the factors affecting teachers' use of ICT (Phase 1 of study)
Face validate instruments
Key:
Research question 1.1:
To what extent did the suitability of available software affect teachers' use of technology?
Research question 1.2:
What other factors affected teachers' use of technology?
Analyse and interpret data
Administer five checklists
Coding and check for inter-coder reliability
Conduct semi-structured interviews
Open coding of interview transcripts and check for inter-coder reliability
Open-coding of initial log for first conference
Complete coding of completed log and check for inter-coder reliability
Chapter 4: Findings for the factors affecting teachers' use of ICT (Phase 1 of study)
Chapter 5: Evaluation of multimedia software package

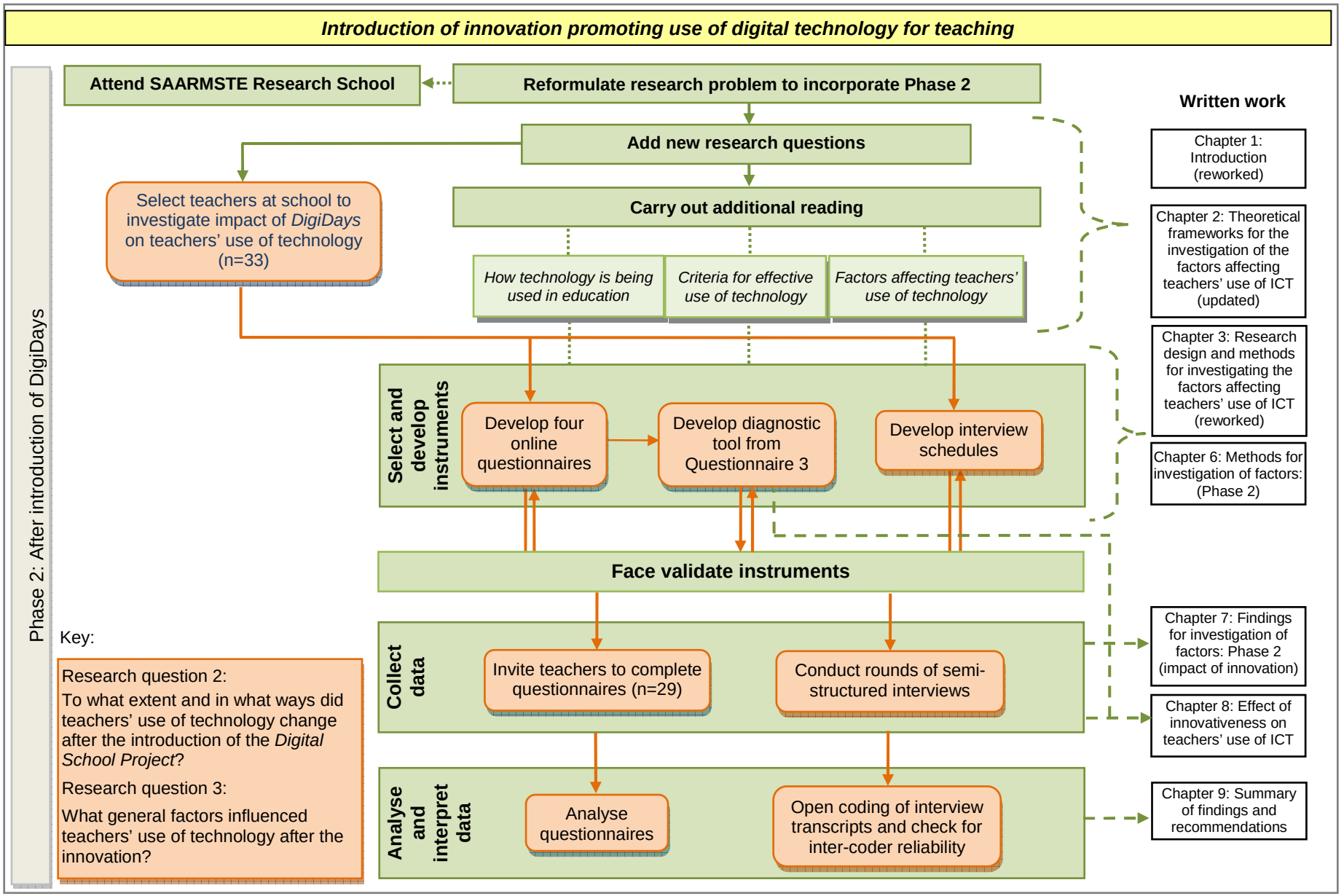


Figure 22. Research design for the study

3.1.2 Research paradigm

Guba and Lincoln (1994, p. 105) define 'paradigm' as "*the basic belief system or worldview that guides the investigator, not only in choices of method, but in ontologically and epistemologically fundamental ways."* Different paradigms reflect different underlying ontologies – that is, different philosophical assumptions about how the facts and principles which constitute knowledge are established, and how that knowledge can be obtained. Different paradigms also reflect different epistemologies – that is, different philosophical assumptions about the relationship between the "*knower or would-be knower and what can be known"* (Guba & Lincoln, 1994, p. 108). Guba and Lincoln point out that the ontological assumptions about the nature of knowledge underlying a paradigm constrain the role of the researcher in obtaining that knowledge (epistemology) and, ultimately, influence the methods available to the researcher to obtain the knowledge (methodology). Because the paradigm within which a researcher works thus influences the way the researcher will investigate the world, Mertens (2005) believes it is important to situate research within a clearly explained research paradigm.

The two major research paradigms traditionally used in education are the positivist paradigm and the constructivist paradigm (McMillan & Schumacher, 2010). The ontological beliefs underlying the positivist paradigm are based on beliefs of a single, external reality that can only be measured quantitatively, often through the use of controlled experimental designs and statistical analysis of the data obtained (Reeves & Hedberg, 2003). The epistemology associated with positivism is that of a separate, objective reality independent of the researcher, the subjects and the measuring instruments used (Gall, Borg, & Gall, 1996; Gorard & Taylor, 2004; Guba & Lincoln, 1994; Mertens, 2005; Wellington, 2000). Based on the epistemological perspective of an 'independent reality', positivists believe reality to be constant from one setting to the next, allowing research findings to be generalised from one setting to another, if the research is carefully designed (Gall et al., 1996; Guba & Lincoln, 1994). Positivists believe that their measurements of this 'independent reality' allow an approximation of the "*real reality*" (Guba & Lincoln, 1994, p. 109). The methods used by researchers situated within this paradigm typically involve empirical testing of a priori hypotheses under strictly controlled conditions. These methods are typically "*designed to collect numbers"* (Greene, Caracelli & Graham, 1989, p. 256). Researchers within this paradigm prefer to be detached from the situation being studied, to promote objectivity (Mertens, 2005; Reeves & Hedberg, 2003; Wellington, 2000). The positivist paradigm is often misleadingly referred to as the 'quantitative' paradigm by researchers who have missed the point that paradigms are identified by the underlying belief system and not by the methods subsequently used.

The strengths of the positivist approach lie in the methods traditionally associated with it: the controlled experimental designs which allow relationships of cause-and-effect to be investigated; the objectivity which comes from the detached position of the researcher; and the statistical methods used for data analysis. Where the strictly controlled manipulated experimental situations used in the positivist paradigms produce replicable results, these results can then be taken as laws which explain phenomena (Guba & Lincoln, 1994). These laws then represent the closest approximation of the 'independent reality'. In the 1970s, however, researchers increasingly started to criticise the use of the

positivist approach for studies of **social phenomena**. One reason for this is that the mechanistic view of human beings required by this approach was considered unrepresentative and unrealistic because the beliefs, attitudes, and behaviours of humans cannot be controlled and manipulated in ways required by the experimental designs associated with the positivist paradigm (Cohen et al., 2000). Instead of the positivist view of human beings as people whose behaviour responds to environmental factors in a cause-and-effect way, many researchers believed that individuals construct their own view of reality (Gall et al., 1996; McMillan & Schumacher, 2010). According to these researchers, the emphasis for research into social phenomena would therefore shift from the positivist aim of predicting people's behaviour in response to environmental conditions, to understanding why people behave as they do. A second criticism of applying positivist methods to social studies is that some researchers believe that trying to hold constant the number of factors required by classical experimental designs to establish a cause-and-effect relationship, ignores the effect of other variables within that particular context "*that might, if allowed to exerted their effects, greatly alter findings*" (Guba & Lincoln, 1994, p. 106). Further, the findings from strictly controlled experimental situations could only be applied to situations where the same variables have been controlled to the same degree, thereby limiting the generalisability, and ultimately, the relevance, of such findings (Gall et al., 1996; Reeves & Hedberg, 2003). In educational research, where the aim of research is to improve education, the manipulation required by experimental designs associated with the positivist paradigm would thus be virtually impossible, rendering such research to have limited potential to improve education. The criticisms of the positivist paradigm led to the development of an alternative paradigm which came to be known as the 'constructivist' paradigm. This term should not be confused with constructivist ideas about learning.

Researchers situated within the constructivist paradigm, in direct reaction to the shortcomings of the positivist paradigm, reject the view of reality upon which the positivist paradigm is based (Reeves & Hedberg, 2003; Mertens, 2005). Subscribers to the constructivist paradigm propose that, instead of the single, independent reality proposed by the positivist paradigm, there exist multiple, individual realities which people construct, both individually and collectively, by ascribing meanings to different aspects of their social environments (Gall et al., 1996; McMillan & Schumacher, 2010; Mertens, 2005). Researchers within the constructivist paradigm use dialectic methods, that is, they investigate respondents' constructions of their social reality provided by the respondents (Gall et al., 1996; Mertens, 2005; Wellington, 2000). The methods used to access people's understandings of their social reality include observations, questionnaires and interviews, i.e. qualitative methods "*designed to collect words"* (Greene et al., 1989, p. 256). Gall et al. (1996) point out that although subscribers to this research paradigm believe that it is possible for there to be multiple realities, internally constructed by different individuals, reality is socially constructed through the use of shared language. This requires an ongoing interaction between the researcher and the subject(s) so that, as Guba and Lincoln (1994, p. 111) explain, "*the findings are literally created as the investigation proceeds*". This socially constructed reality is located within a specific context and time frame and is not necessarily applicable to other contexts and times (Gall et al., 1996; Mertens, 2005), thus limiting generalisability of findings. Studies conducted within this paradigm tend to focus on particular cases rather than large samples of a population, as case studies allow a particular context-bound reality to be fully explored and described (Gall et al., 1996). Researchers working within the constructivist paradigm are not

required to be detached from the context of their research study (Mertens, 2005; Reeves & Hedberg, 2003). Instead, researchers are intimately involved in choosing which data to collect, interpreting the data according to their own construction and interpretation of the social reality revealed by the subjects, and choosing which data to report (Creswell, 2012; Gall et al., 1996). The constructivist paradigm is often misleadingly referred to as the 'qualitative' paradigm, when researchers incorrectly focus on the methods associated with the paradigm, rather than the underlying belief system.

The extent of researchers' involvement with subjects, typical of research conducted within the constructivist paradigm, gives rise to a major strength and a major weakness of constructivist research. The strength is that researchers, through interacting with their respondents, can form strong relationships with the subjects of the research, which might make it easier for the subjects to reveal to researchers how they have constructed their social reality. Mertens (2005) doesn't regard the degree of involvement of constructivist researchers as a weakness. She suggests that the interactive approach used by constructivist researchers may "*yield better interpretations of meanings*" that respondents attach to activities and events (Mertens, 2005, p. 15). This generates a weakness pointed out by positivist researchers – that the degree of involvement of constructivist researchers contributes to the subjectivity of constructivist reporting and thereby potentially weakens the validity of the research findings (Cohen et al., 2000; Gall et al., 1996; Marshall & Rossman, 1989; Reeves & Hedberg, 2003). Another potential weakness of constructivist research is the problem of low generalisability. Constructivist research is generally not applicable to contexts other than the one being investigated (Gall et al., 1996; Mertens, 2005). The onus for generalising from constructivist research may fall on the individual wanting to generalise from a particular constructivist study. Because constructivist research is based on people revealing to researchers their versions of reality, Guba and Lincoln (1994, p. 115) point out other potential problems with constructivist research, namely the possibility of deception and potential "*interpersonal difficulties*" between respondents and researchers.

The dogmatic stance adopted by some researchers about adhering to a particular paradigm and methods of data collection associated with that paradigm, led to a polarisation of the positivist and constructivist paradigms, which played out in the 'paradigm debate' of the 1980s and the 1990s (Creswell, 2012; Gorard & Taylor, 2004; Tashakkori & Teddlie, 1998). In contrast to researchers who believed that "*different paradigms typically embody incompatible assumptions about the nature of the world and what is important to know, for example, realist versus relativist ontologies*" Greene et al. (1989, p. 257), other researchers (e.g. Gorard & Taylor, 2004; Reeves & Hedberg, 2003; Wellington, 2000) suggest that researchers who believe that a particular belief system limits them to a particular set of qualitative or quantitative methods might be confusing the design of a study with the methods of collecting data. Gorard and Taylor believe that the research approach and methods used in a study should not be predetermined based on methodological differences, but selected because they are the best way to answer the research questions for a particular study. Gorard and Taylor explain why they advocate combining quantitative and qualitative methods when conducting educational research:

> *Quantitative and qualitative methods are, in this model, merely tools for researchers to use as and when appropriate. But we suggest that they are nearly always more powerful when used in combination than in isolation. We do not mean by combining methods simply that both qualitative and quantitative traditions should be in evidence in any one department, research group or project. In fact*

> *the identification of separate qualitative and quantitative elements within a project can be one of the biggest obstacles to the proper integration. Rather, we are referring to work in which different forms of data are put together to make a more coherent, rational and rigorous whole.* (Gorard & Taylor, 2004, p. 4)

A third paradigm emerged in the early 1980s which overcomes the polarisation which exists between the proponents of the constructivist and positivist paradigms. Researchers situated in the third paradigm do not hold any ultimate conception of reality as their underlying ontology, and avoid "*the use of metaphysical concepts such as truth and reality*" (Mertens, 2005, p.25). Instead, researchers in this paradigm believe that the best approach to educational research is a *pragmatic* one in which the value of research is judged by its effectiveness in finding solutions to research problems rather than searching for some 'truth' (Mertens, 2005; Tashakkori & Teddlie, 1998). Researchers working within this paradigm reject the idea of "*epistemological purity*", and "*argue pragmatically that paradigm attributes are logically independent and therefore can be mixed and matched, in conjunction with methods choices, to achieve the combination most appropriate for a given inquiry problem*" (Greene et al., 1989, p. 257). This paradigmatic orientation rejects the idea of having to choose between a purely positivist or constructivist approach and is not limited to a particular set of data collection methods or data analysis strategies associated with either of the traditional paradigms (Gorard & Taylor, 2004; Mertens, 2005; Reeves & Hedberg, 2003). Rather, researchers are free to choose methods that will best answer the research questions (Gorard & Taylor, 2004; Mertens, 2005).

Originally formalized by Patton (1980) under the name "*the paradigm of choices*", this third paradigm has been referred to by various other names. Some researchers and authors use the name 'mixed methods' paradigm (Creswell, 2012; Greene et al., 1989; Johnson & Ongwuebuzie, 2004; McMillan & Schumacher, 2010; Teddlie & Tashakkori, 2003). This name, however, is inappropriate for the same reason that the terms 'qualitative' and 'quantitative' are inappropriate when used to refer to the constructivist and positivist paradigms, respectively. Naming a paradigm based on the typical methods used focuses attention on the methods associated with the paradigm rather than on the belief system underpinning the paradigm. Reeves and Hedberg (2003) refer to the third paradigm as the *eclectic – mixed methods – pragmatic paradigm*[5], a name helpful in allowing researchers to understand the belief system underlying this paradigm:

- 'eclectic' – is defined in the Oxford Advanced Learner's Dictionary (Hornby, 1998, p. 367) as "*not following only one style, set of ideas etc. but choosing from or using a wide range*". The use of this term refers to the fact that subscribers to this paradigm will mix or combine "*quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study*" (Johnson & Ongwuegbuzie, 2004, p. 17).
- 'mixed methods' means that one mode of inquiry is not valued over another. Instead subscribers to this paradigm will use methods traditionally associated with other paradigms if those methods lead to better understanding of the situation (Johnson & Onwuegbuzie, 2004; Mertens, 2005).

[5] Reeves and Hedberg (2003) used hyphens between the three terms which awkwardly combined the words 'eclectic' and 'mixed', then 'methods' and 'pragmatic' . Dashes have been used here to clearly separate the three terms which make up the name.

- ‘pragmatic’ – is defined in the Oxford Advanced Learner’s Dictionary (Hornby, 1998, p. 905) as “*concerned with actual circumstances rather than general theories*” – and refers to the fact that researchers who subscribe to this paradigm are focused on finding practical solutions to problems rather than being restricted by the beliefs of a single paradigm and using the methods dictated by these beliefs (Mertens, 2005; Reeves & Hedberg, 2003).

The full name of *eclectic – mixed methods – pragmatic paradigm* used by Reeves and Hedberg (2003), while useful in describing the nature of the paradigm, is cumbersome to use. Because the name “mixed methods” is deemed inappropriate for describing a belief system, and because the name “eclectic – mixed methods – pragmatic paradigm” is cumbersome, this paradigm will be referred to in this study as the *pragmatic* paradigm, as has been done by Mertens (2005) and others. This name more accurately reflects the pragmatic belief system which underpins the work of researchers situated in this paradigm, i.e. that the research approach and methods are selected because they are the best way to answer the research questions for a particular study.

Neither of the first two paradigms was regarded as accurately reflecting my belief system. Instead, the pragmatic paradigm described my beliefs about research and offered me the freedom to focus on finding useful answers to the research questions. I chose not to be limited to the data collection methods traditionally associated with either of the two classical paradigms. Instead I chose to select and combine data collection methods according to their suitability for providing data that would allow the different research questions to be answered, and the data sources being used – benefits of the pragmatic paradigm which have been acknowledged by many researchers (e.g. Gorard & Taylor, 2004; Johnson & Ongwuegbuzie, 2004; Mertens, 2005; Reeves & Hedberg, 2003).

3.1.3 Research approach

Case studies

Gall et al. (1996, p. 545) describe case study research as an “*in-depth study of instances of a phenomenon in its natural context and from the perspective of the participants involved in the phenomenon*”. Addressing the research questions for this study required a research approach that would allow both an evaluation of a software package available at the school at which I was teaching at the time I began the study, and an exploration of how teachers at this school were using computers and what factors influence their use of computers for teaching. This type of exploration would depend heavily on the context and setting of the study and peoples’ frame of reference in relation to the research topic (which would be influenced by factors like a person’s role and responsibilities in the situation). In addition, this type of study would require an in-depth understanding of the formal and informal processes operating in the research situation, as pointed out by Creswell (2012) and Marshall and Rossman (1989). I decided that a case study design was the best approach to use for this type of exploration because the study involved a single unit, would be context bound, and would require an in-depth study of the attitudes and values of the people involved – factors which comply with the description of case studies used by Miles and Huberman (1994), by Gall et al. (1996) and by McMillan and Schumacher (2010).

The fact that case studies focus on a single unit gives rise to the main strength and the main weakness of this research approach. The strength of the approach lies in the significance of carrying out a detailed study within the particular context of the research setting, which affords the researcher a greater degree of insight into various phenomena (Fraenkel et al., 2012). The focus on a single unit, however, limits the generalisability or transferability of the findings of such studies to other situations, especially where the case study is conducted as a single-site case study (Cohen et al., 2000; Fraenkel et al., 2012; Gall et al., 1996; Marshall & Rossman, 1989; Wellington, 2000). Some researchers have pointed out, however, that the aim of case study research is not the transfer of findings to other settings, but rather the attempt to understand a phenomenon as fully as possible from the perspective of the people participating in the case study (Marshall & Rossman, 1989; McMillan & Schumacher, 2010; Wellington, 2000). Flyvbjerg (2006, p. 225) emphasises that the generalisability of the findings from case-study research "*depends on the case one is speaking of and how it is chosen*". Once the findings emerging from case studies have been presented, the onus for judging the transferability of the findings must then rest with those reading the case study, who must apply their pre-existing knowledge and experience of similar cases to judge the applicability of the findings of the case study to other situations (Mertens, 2005; Wellington, 2000).

Despite the limited transferability of case studies, I decided that a case study approach would allow the deep exploration and intensive analysis of the behaviour of the teachers at the school and the reasons for their actions. This depth was required to establish what factors influenced the teachers' use of computers. As explained by Wellington (2000), it was considered important to investigate the phenomenon as fully as possible and to present and interpret the findings in the best way possible so as to allow others to relate to the case being studied and learn from it, rather than trying to generalise from it.

The setting for this case study

The reader is reminded of the purpose of the study, which was conducted in two phases. The study initially focused on evaluating the suitability of a multimedia software package (available at the school at which I was teaching) as support material for teachers' adopting a new curriculum, which had been introduced at that time. The designers of the software package claimed it could help teachers implement the practices and teach additional content introduced as part of the new curriculum. The first phase of the study was subsequently expanded to investigate other factors, besides software quality, which impacted on teachers' use of technology at a secondary school. The second phase of the study focused on the introduction of an innovation promoting the use of digital technology for teaching and learning, at the school. The innovation provided an opportunity to investigate, in more detail, the impact of certain factors (e.g. the provision of in-service training) on teachers' uptake of technology.

The school formed the setting for the study. There were a number of reasons why the school provided a suitable setting within which to conduct the study. The main reason was that it has ICT facilities and resources for teachers to include computer technologies in their teaching if they choose to. At the beginning of the study these facilities included a computer laboratory with sufficient computers for every learner in a class (to a maximum of 25), internet connectivity in some areas of the school,

computers for staff use and an interactive whiteboard. Over the course of the study the ICT facilities gradually increased[6]. The introduction of an innovation promoting the use of the digital technology for teaching and learning allowed the study to move into a second phase (see Figure 22, pages 64-65). As part of the ongoing innovation, called the *Digital School Project*, teachers were provided with additional ICT resources in the form of data projectors for their classrooms and the option to purchase a laptop through a scheme[7] set up by the school. A learning management system called *Moodle* was set up at the school, which led to the introduction of dedicated digital technology days or *DigDays*[8]. As part of the *Digital School Project* teachers were also provided with additional ICT training, including how to use *Moodle*. '*DigDays*' is widely used by teachers as a catch-all term for the whole *Digital School Project*. However, in this write-up, I will use *DigDays* to refer to the dedicated technology days and the *Digital School Project* to refer to the larger project.

Sampling

The three different samples for this study are shown in Figure 23.

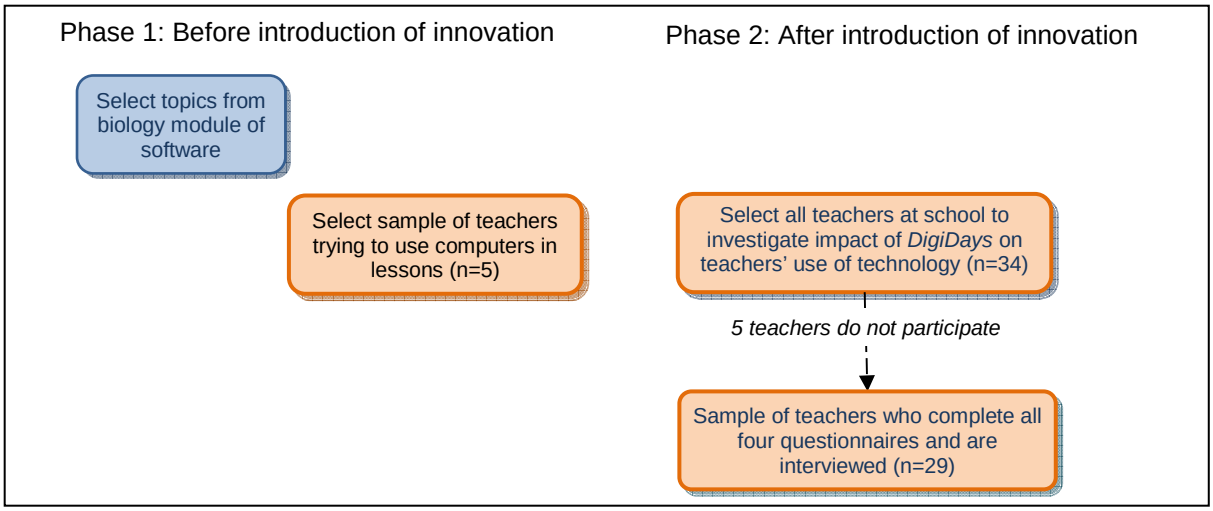


Figure 23. Sampling in this study

The multimedia software package available at the school constitutes the first sample (see Figure 23). Because the software evaluation is described in a separate chapter, details of the selection of topics from the biology module of the software package are discussed later (Chapter 5, page 148). The sample of teachers interviewed during the first phase of the study (n = 5), and the sample of teachers for the second phase of the study, after the *Digital School Project* was introduced, (n = 29) constitute the second sample (see Figure 23). For the second phase of the study, all 34 teachers in the college

[6] A second computer lab with another 25 computers was introduced; data projectors were installed in more classes; internet connectivity was extended to more areas of the school.

[7] Teachers had to purchase their own laptops as part of a laptop scheme run by school. Teachers would repay the cost of the laptop and insurance costs for the machine to the school over a period of three years.

[8] '*DigiDays*' is a contraction of *Digital Days*. *DigiDays* are held one Friday a month during the school term. On *DigiDays* the formal timetable is suspended. Teachers load tasks onto *Moodle* for learners to complete at home and submit by uploading onto *Moodle*.

at that time were invited to participate in the study. Thirty-one of the 34 responded to the first questionnaire I sent out. One of the two non-respondents was on a prolonged leave of absence from her duties and the other teacher declined to participate (no reason given). Of the 32 respondents to the first questionnaire, three teachers left the school between the administration of the first and second questionnaires and were therefore not included in the final sample. The remaining 29 teachers formed the sample for both the questionnaires and the interviews conducted during the second phase of the study.

All samples, both for the software package and the teachers, qualify as convenience samples, which are described as samples which are readily available for study (Cohen et al., 2000; Creswell, 2012; Fraenkel et al., 2012; Gall et al., 1996; McMillan & Schumacher, 2010).

Type of observer participation

There are two possible roles that researchers can assume when carrying out observations in case studies: they can either be participant-observers or non-participant observers (Cohen et al., 2000; Creswell, 2012). Non-participant observers make their observations strictly from outside of the group and do not directly participate in any of the group activities (Creswell, 2012). By contrast, participant-observers are researchers who make observations of group activities from within the group being studied, while participating in the same types of activities as the rest of the group (Cohen et al., 2000; Creswell, 2012; Fraenkel et al., 2012). Using the description of Fraenkel et al. I was an "*overt"* participant observer, "*in the sense that the researcher is easily identified and that the subjects know that they are being observed"* (Fraenkel et al, 2012, p. 446). During the initial phase of the study, it was logical for me, as a teacher at the school and therefore an active member of the group, to use the participant-observer approach. However, after the introduction of the *Digital School Project* promoting the use of digital technology for instruction, which allowed a deeper investigation of three factors previously identified as influencing teachers' use of technology (time to use ICT for instruction, in-service training, and teachers' level of innovativeness), I was no longer teaching at the school and my role changed to that of non-participant observer. I therefore had to apply for permission to continue the research at the school, as will be discussed in Section 3.5, which deals with ethical considerations for the study.

3.2 METHODS FOR THE INVESTIGATION INTO FACTORS AFFECTING TEACHERS' USE OF ICT

The reader is reminded of the context of the study: the school at which the researcher was teaching at the beginning of this study and where teachers were attempting to include technology in their teaching, whilst at the same time implementing the changes in classroom practice required by the new South African school curriculum being implemented at the Further Education and Training (FET) level. Against this background, the study was initially motivated by the need to evaluate how suitable a software package would be in supporting teachers through a period of curriculum change. The package claimed to have been designed according the principles of the new curriculum being introduced in the country at that time. If the designers' claims were true, software of this nature could provide valuable support for teachers being required to teach new content and to adopt radical new

teaching practices, as required by the new curriculum. However, software quality emerged as only one of many factors impacting on teachers' use of ICT, which led to an investigation of other factors affecting technology use for instruction. The research question and sub-questions for the first phase of the study are restated below:

Research question 1: What factors affect teachers' use of information and communication technology at a case study school?

1.1 To what extent did the suitability of available software affect teachers' use of technology?

1.2 What other factors affected teachers' use of technology?

The findings of the investigation into the factors influencing teachers' use of ICT are presented in Chapter 4, which includes a summary of the impact of software quality as a factor impacting on teachers' use of ICT. Because of its comprehensiveness, details of the methods of evaluation of the *EduRom* package, and specific results of the evaluation, are presented separately, in Chapter 5, despite the evaluation having being carried out during the first phase of the study.

According to Marshall and Rossman (1989) and Fraenkel et al. (2012) the *methods* of data collection selected for use in a study must relate to the *type* of information the study is aiming to collect. Using a pragmatic approach, the methods used in this study were selected for their suitability in allowing the collection of data that, once analysed, would reveal answers to the research questions. Two methods were used to collect data on the factors affecting teacher's use of ICT during the first phase of the study – a researcher's log and interviews with four teachers (to give a sample of five as shown in Figure 23).

3.2.1 Researcher's log

Logs typically contain both descriptive data (describing the settings of events and what took place, without the researcher delivering any evaluation on the events) and reflective data (researchers' thoughts about events being recorded) (Creswell, 2012; Ely, 1991; Fraenkel et al., 2012).

There are various ways in which researchers can choose to write about their observations in the field. Fraenkel et al. (2012) distinguish between field jottings (brief notes which the researcher will expand upon at a later, more convenient stage by adding more detail), field notes (detailed notes taken by the researcher of events unfolding that are relevant to the research), a field diary (a record of the researcher's personal opinions and feelings about people encountered in the course of the observations) and a field log (an outline of how the researcher intends to collect data). Ely (1991, p. 69) introduced a fifth term, '*researcher's log'*, which she describes as a "*chronological record of what we learn and our insights about how we learn it*". I decided to use a researcher's log in this study. My decision to use a researcher's log was motivated by two factors. Firstly, a researcher's log seemed best suited to record as much detail as possible about those events relating to the use of ICT to which I was privy in the case study school. Secondly, logs provide a permanent record of the researcher's

observations and feelings or thoughts about the observations and can be preserved for re-analysis and checking.

At the beginning of my study, I kept written notes in an A4 hardcover book. After a year of recording my log in a book, I switched to using a word processor. I transcribed the written log to provide a complete digital log for analysis. My notes (hand-written and typed) consisted of my descriptions of my observations and reflective comments on my observations, as shown in the extract from my log in Figure 24. According to Ely (1991), reflective notes play an important part in the analytical process. As Ely (1991, p. 80) explains, researchers' "*spontaneous*" comments on observations recorded in their logs could eventually "*become part of the log*". Ely suggests that researchers' reflective notes could be used in a number of ways. Firstly, reflective notes may be further developed into 'analytical memos'. Creswell (2012) describes the memos as notes researchers write to themselves about the observation and research process. The analytical memos then become part of the log. Secondly, the researcher may use reflective notes to suggest analytical categories to be further explored at a later stage, as well as a means of attempting to control subjectivity.

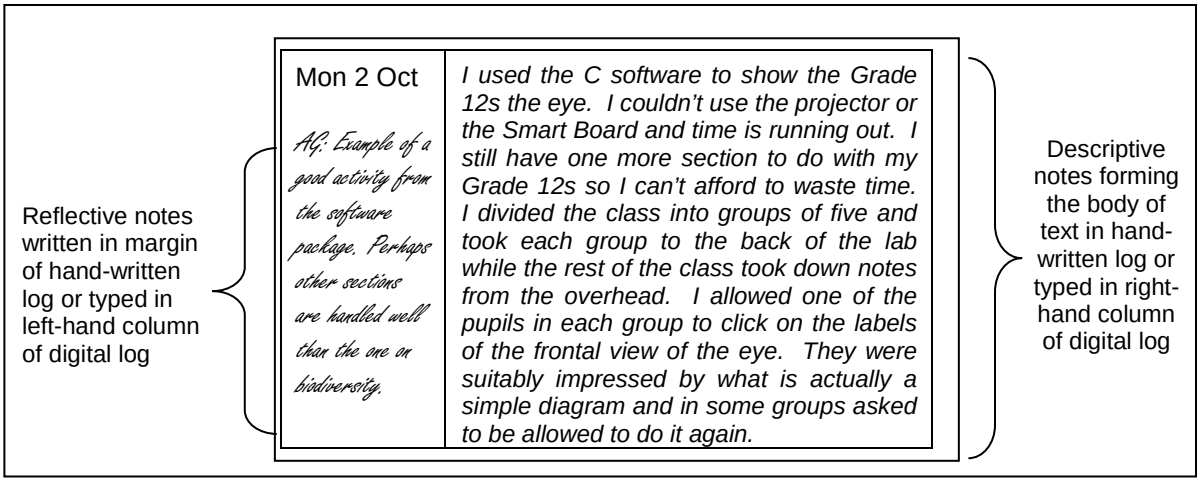


Figure 24. An extract from my digital log showing descriptive and reflective notes

Before analysing the log I added line numbers to make it easier to cite extracts from the log at a later stage. The log was checked by an experienced researcher at various stages during the period of data collection (two years) to ensure the use of "*thick description*" (Guba & Lincoln, 1983, p. 326), and the coherence and logic of the recordings. The definition of 'thick description' will be discussed in greater detail in Section 3.4.1 on page 83. Once I thought that I had collected sufficient data to allow a fair and accurate analysis of the use of computer technology in the school and the factors surrounding it, I suspended the log recordings so that the log data could be analysed. The log was analysed using open-coding, described on pages 80-81.

One of the major disadvantages associated with keeping logs is a potential problem with the lack of objectivity of the researcher who is keeping the log. Fraenkel et al. (2012, p. 448) point out that observations made by any researcher will always be subject to some degree of bias, but that researchers should aim to "*study the subjective factors objectively*". It has been said that "*...*

observation can never be objective and ... will never be judgement-free. This is so because observation comes out of what the observer selects to see and chooses to note" (Ely, 1991, p. 53). Ely believes that the best researchers can do in the pursuit of objectivity – while acknowledging that pure objectivity is a practically impossible goal for a participant-observer immersed in the very situation under observation – is to be self-aware and to strive to observe fairly and minimise any biases that arise. Ely advocates that the researcher keeping the log should employ techniques that can be used to ensure the log will generate data useful for analysis. I used the following techniques, as suggested by Ely, to record my observations accurately and minimise subjectivity:

- I recorded log entries as soon as possible after an event, so as to be able to record sufficient detail of the event. Ely suggests that researchers should record events as soon as possible after they have occurred to minimise the loss of detail.
- I tried to include sufficient detail of the setting and activities of the role players to allow the event to be reconstructed in the minds of others reading the log. Recording sufficient detail surrounding events is essential to allow readers of the log to reconstitute the event in their minds. In the words of Ely (1991, p. 70) "*detail is everything*" when keeping a researcher's log. Including sufficient detail to 'set the scene' would help readers understand any inferences I made from the event. Guba and Lincoln (1983, p. 326) use the phrase "*thick description*" in relation to researchers including many details surrounding events in their recording.
- I separated my descriptive and reflective notes in both the written and digital logs. Ely advocates separating descriptions of actual events from the researcher's feelings and thoughts about events as recorded in the reflective notes. By separating the purely factual account of events and the researcher's feelings and interpretations of the events that transpired, the researcher is making a clear distinction between the two types of data, which could make it easier to control subjectivity (Ely, 1991; Fraenkel et al., 2012). The reflective notes can then be viewed as the researcher's ongoing evaluation of events, which, as stated by Fraenkel et al. (2012), is what good research requires. Although I initially found it difficult to describe observations in the descriptive notes and limit my evaluations of situations to the reflective notes, over time I became more accomplished at doing this.
- I have, where relevant, cited extracts from the log in the chapters reporting on the investigation into factors affecting teachers' use of computers for teaching and learning (Chapters 5 and 6), as evidence for claims made in my report. Ely advocates presenting data from the researchers' log as a method of controlling observer subjectivity, because it makes the raw data available for analysis and/or evaluation by other researchers. I used extracts because the entire log was too long to include as data from the study.

3.2.2 Interviews

Interviews and questionnaires are often compared and contrasted with respect to their relative strengths and weaknesses (see e.g. Fraenkel et al., 2012; Gall et al., 1996). Table 5 gives the advantages of interviews over questionnaires. Many of these advantages relate to the presence of the researcher during interviews, which allows deeper probing of respondents' answers. According to

Fraenkel et al. (2012), interviews are used to explore what people think or how they feel about a situation. It is this aspect of interviewing, namely, the opportunity to probe peoples' thoughts, which warranted the use of interviews in this study. I interviewed teachers to gain a deeper insight into factors affecting teachers' use of computers not readily evident from my observations and the data collected from questionnaires, e.g. teachers' attitudes towards using technology in their teaching.

Table 5. Advantages of interviews over questionnaires

Interviews	Questionnaires
The researcher can clarify questions respondents do not understand (Gall et al., 1996).	The researcher is not to present to explain questions respondents do not understand.
The researcher can probe respondents' answers to clarify vague or incomplete answers (Cohen et al., 2000; Fraenkel et al., 2012; Gall et al., 1996; McMillan & Schumacher, 2010).	The researcher's absence means respondents' answers cannot immediately be followed up.
The researcher can establish a rapport with respondents which may make it easier for respondents to reveal information that they may not otherwise have mentioned (Gall et al., 1996).	The researcher's absence makes it difficult to establish a rapport with the respondent.
The researcher can monitor both the verbal and non-verbal behaviour of respondents (McMillan & Schumacher, 2010).	The researcher's absence makes it impossible to monitor non-verbal behaviour of respondents.
Respondents can answer using words of their own (Schumacher & McMillan, 1993). This can be useful to researchers because it can either support or contradict researchers' perceptions of respondents' viewpoints (Wellington, 2000).	Depending on the type of questions included in the questionnaire, respondents may not be able to answer in their own words.

Development of the interview schedule

Most researchers recognise three types of interviews based on the degree of structure of the interview. In '**structured**' interviews researchers use a list of questions (or interview schedule) from which they do not deviate, either in wording or sequence (Gall et al., 1996; McMillan & Schumacher, 2010; Wellington, 2000). Fraenkel et al. (2012, p. 452) point out that structured interviews, while they allow for easier data analysis, allow researchers no flexibility when asking questions, which may contribute to respondents perceiving the interview process as "*mechanistic"*. In '**unstructured**' interviews the researcher does not use an interview schedule. Rather, the sequence and wording of the questions are decided on by the researcher during the interview (Gall et al., 1996; McMillan & Schumacher, 2010; Wellington, 2000). The lack of structure and preparation, and having to formulate questions on the spur of the moment, may make it is difficult for less experienced researchers to control the direction of the interview and remain focused on the objective of the interview (Wellington, 2000). A particular risk of unstructured interviews is that researchers may neglect to ask important questions which must be addressed to obtain the necessary data to answer the research questions (Wellington, 2000). Fraenkel et al. (2012) raise concerns about ethical issues during informal interviews should the unstructured line of questioning lead to personal questions. In '**semi-structured**' interviews the interviewer uses a schedule of structured questions, but has the flexibility to probe more deeply and deviate from the interview schedule where needed (Gall et al., 1996; McMillan & Schumacher, 2010; Wellington, 2000). I used semi-structured interviews in this study, because this structure allowed me the flexibility to probe teachers' answers to the questionnaires, while still working within the framework of an interview schedule to guide me.

The final interview schedule for the interviews (n=4) conducted during the first phase of the study is included as Appendix I.
The interview schedule was face validated by a researcher experienced in developing and checking interview schedules. This researcher checked the questions included in the schedule, the logical clustering and sequencing of questions into specific groups, and the wording of questions to elicit the information necessary to answer the research questions. An iterative cycle of checking and modification then followed, intended to improve the validity of the interview schedules used in each phase of the study. Some questions were rephrased to remove ambiguities, as well as to minimise the use of leading questions. Such questions are undesirable as the wording tends to influence the respondent to select a particular answer over other possible answers, thus introducing bias (Schumacher & McMillan, 1993).

Procedure during the interviews

All interviews conducted during this study were tape-recorded using a digital recorder. Permission to record the interviews had been obtained from the interviewees when they signed informed consent sheets distributed to potential participants at the beginning of the study. A digital recorder was used because they generally offer the benefit of good quality sound. They are also smaller and less conspicuous, which makes the process of recording the interview less overtly intrusive to the respondent. Using a digital recorder allowed me to reduce the risk of the process of recording the interview making the respondent uneasy and less forthcoming, which Gall et al. (1996) and McMillan and Schumacher (2010) warn about. Fraenkel et al. (2012, p. 457) regard a recording device as "*indispensable"* when conducting interviews. Tape-recording the interview eliminates the problems associated with note-taking interfering with the continuity of interviews and can allow the speedy compilation of complete, accurate and objective records of interviews, providing recordings are clear and accurately transcribed (Cohen et al., 2000). Data transcribed from clear recordings can also be analysed more thoroughly than hastily scribbled interviewers' notes (Gall et al., 1996).

Fraenkel et al. (2012) provide a list of appropriate behaviour for interviewers when conducting interviews, including behaving naturally, listening actively, and allowing respondents to talk without interrupting them. While I feel that my interviewing technique improved over the duration of the interviews, I was acutely aware of a potential source of bias. As a teacher interviewing other teachers about the use of ICT, I was cautious of asking questions in a way that implied I was judging a teacher's responses about the use or non-use of technology, which could have influenced teachers' answers. My strategy to deal with this potential problem was to deliver the questions in an even tone, while making eye contact with the teacher, but avoiding any overt body language which the teacher could interpret as a suggestion that I found their answer acceptable or not acceptable. In one interview, in particular, I found it difficult to maintain a neutral stance. The teacher being interviewed was acutely aware of her lack of use of technology, and vacillated between being embarrassed by her non-use and being angry that she was expected to use technology. My natural tendency was to allay her fears, which I did to make her feel comfortable during the interview.

During the first phase of this study all four interviews were conducted in the classrooms of the respondents at a mutually convenient time. Immediately after each interview I transferred the audio clip onto my computer and labelled the sound clip firstly with the date of the interview, and, secondly, with a number assigned to the teacher to preserve the teacher's anonymity. After I had transcribed the tapes, transcripts were checked (all three transcripts for the first round of interviews, and a subset for the second round of interviews) by my supervisor to ensure the accuracy of the transcripts in comparison to the tape recordings. This process was carried out to improve the rigour in the study.

3.3 CONTENT ANALYSIS OF INTERVIEWS AND RESEACHERS' LOG

In any study the raw data which has been collected must be organised, reviewed and interpreted to search for patterns in the data (Krippendorf, 2013; Marshall & Rossman, 1989; Miles & Huberman, 1994). Case studies typically generate large volumes of observational notes and interview transcripts, which need to be analysed to produce meaningful findings (Ely, 1991; Marshall & Rossman, 1989; Wellington, 2000).

Bos and Tarnai (1999, p. 660) describe content analysis as "*a means of analysing texts"* suitable for analysing data from *"individual case studies"*. I have already discussed the process of content analysis in Chapter 2 (see page 26) in the context of identifying factors from the literature when developing a conceptual framework for the investigation of the factors affecting teachers' use of ICT for instruction at the case study school. I also used content analysis to analyse the data from my log and the interviews conducted during both phases of tthe study.

Although Miles and Huberman (1994) believe there is no standard approach when analysing qualitative data, Figure 25 shows a summary of the general process typically followed. Open-coding is typically inductive, with the factors and categories emerging from the data (Ely, 1991; McMillan & Schumacher, 2010; Miles & Huberman, 1994; Wellington, 2000).

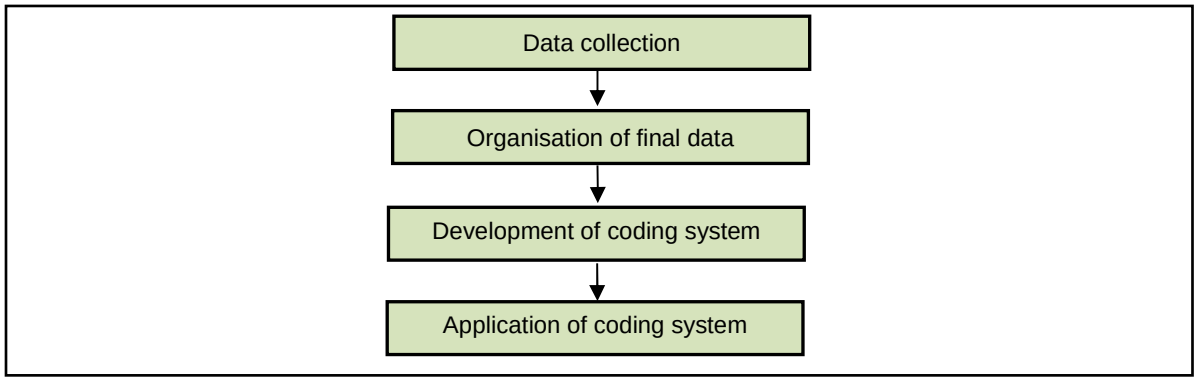


Figure 25. A summary of the process of analysing qualitative data (based on Creswell, 2012; Marshall & Rossman, 1989; and McMillan & Schumacher, 2010)

3.3.1 Preliminary data analysis as data was still being collected

Mertens (2005) points out that analysing data throughout the collection process allows researchers to make continuous discoveries about the data. Such discovery can lead to the need for modification of the data collection process or for further data collection until the final volume of data is ready for final analysis (Creswell, 2012; Ely, 1991; Miles & Huberman, 1994; Schumacher & McMillan, 1993).I began analysing my researcher's log as it was being compiled. The early analysis made me realise that factors other than software quality were affecting teachers' use of technology at the case study school. This awareness led to the aims of the study being broadened. It was expanded from the initial focus on evaluating the quality of a multimedia software package, within the context of the requirements of the new South African curriculum, to include an investigation of other factors impacting on teachers' use of computers for teaching and learning.

3.3.2 Organisation of data prior to analysis

Once I had collected all the data, I converted the texts from the journal and the interviews to a digital format for processing. This included completing transcribing the earlier, hand-written portion of the log. I also prepared the transcripts of the interviews for the final analysis by adding line numbers to the text for easy reference (as suggested by Gall et al., 1996) and replacing the names of respondents and other role players with identifying codes, e.g. T1 for the first teacher and A1 for the first administrative person involved in the study.

3.3.3 Development and application of the coding system

Developing the coding system that will be used to analyse texts can be regarded as "*a central objective of content analysis"* (Bos & Tarnai, 1999, p. 666). I used open coding to develop the classification system for analysing the interviews and researcher's log, as summarised below:

> **Step 1: Identifying and isolating data segments.** The first step in developing the coding system to analyse my texts involved examining each transcript to identify segments of data that contained a single concept. Miles and Huberman (1994) define a 'concept' as "*words grouped together into conceptual clusters (ideas)"*. Before isolating the data segments, I read the transcripts a number of times. The literature suggests that reading and rereading the text helps to familiarise oneself with the data and facilitates the identification of concepts emerging from the data (see Fraenkel et al., 2012; Miles & Huberman, 1994; Wellington, 2000). In this study the conceptual clusters related to individual factors affecting teachers' use of technology. I compiled a list of factors emerging from the data.
>
> **Step 2: Grouping concepts into categories and subcategories.** Bos and Tarnai (1999, p. 666) emphasise the importance of developing "*a reliable and valid category-system"*. The system of categories and subcategories into which concepts are clustered to form the coding system is an important step in the process of open coding, because the categories and sub-categories "*represent major ideas"* emerging from the data (McMillan & Schumacher, 2010, p. 376). Clustering like concepts together into a smaller number of groups allows researchers to

better visualise the major themes emerging from the data, and to better handle large numbers of concepts. The factors in the list compiled in the previous step were clustered into groups based on common themes. Each category and subcategory was then named and defined according to the central idea it embodied. For example, my coding system included a category named '*Hardware-related issues'*, which was defined as "*Issues relating to the hardware available to teachers' for teaching and learning*". This category was divided into three subcategories labelled '*Availability of hardware'*, '*Accessibility of hardware*' and '*Functionality of equipment'*. Each subcategory was defined to explicitly state the concept associated with it. Once the category system had been developed, it was submitted to an experienced researcher for face validation, which involved the researcher checking that the categories and subcategories had been appropriately identified, named and defined, and that the process of categorisation was complete. Categorisation is considered complete at the point of theoretical saturation, that is, when no new categories can be added when more data is analysed, no new items can be added to any category, and the relationships between the different categories appears to be well established (Gall et al., 1996; Miles & Huberman, 1994). Based on the feedback from the validator, changes were made to the coding system, for example, changing the names of categories to better reflect the major idea they represented.

Step 3: Assigning codes to categories. Once the category system had been validated, I assigned codes (labels for the data segments identified in step 1) to the factors, categories, and sub-categories. As Miles and Huberman (1994) explain, the codes are used only for the convenience of the researcher, to save time and effort, and are generally not used in reporting. The system of codes assigned to categories was also presented for face validation, to check whether the validator agreed with the naming of codes and the allocation of codes to categories. Any discrepancies in allocating codes to categories between the second researcher and I were discussed until mutual agreement was reached and, where appropriate, the coding system was changed.

Bos and Tarnai (1999) and Miles and Huberman (1994), point out that coding is an iterative process, often involving many cycles of analysis, which is exactly what I experienced. Once I began using **t**he coding system to code transcripts new factors affecting teachers' use of ICT emerged from the data. These new factors meant that I had to revise the category system, and go back and recode transcripts coded earlier. Coding has been described as "*hard work*", but also rewarding as "*the puzzle pieces come together to form a more complete picture*" (Miles & Huberman, 1994, p. 245). Inter-coder reliability was used to improve the rigour of the analysis (see the next section).

3.4 RIGOUR

Wellington (2000), in attempting to answer the question "*What's the use of educational research?*", suggests three possible benefits that educational research offers the larger education community:

- Educational research can provide insights into educational situations, policies and practices.

- Educational research, while not always able to establish "*direct causal relationships*" between factors (Wellington, 2000, p. 182), can highlight the relationships or connections between factors.
- Educational research can provide critical commentary on educational initiatives and practices.

In final answer to his question Wellington concludes that "*educational research can make education better*" (Wellington, 2000, p. 183). As pointed out previously (see introduction to Chapter 1, on page 1), the findings from this study could provide valuable lessons for educational institutions attempting to use computer technology for teaching and learning. However, before any educational research can be used to make education better, the reliability and validity of such studies must be demonstrated. Guba and Lincoln (1983) point out that reliability and validity are vitally important because they determine the trustworthiness of research findings. For my study to be used to improve education, I would have to describe the methods I used to improve rigour, thus demonstrating steps taken to improve the trustworthiness of my findings.

When discussing rigour for this mixed-methods study, I will use the terms generalisability, reliability and validity. The use of the term 'generalisability' is justified (see Section 3.4.1 below) on the grounds that this research is a case study, but my use of the terms 'reliability' and 'validity' requires further discussion. Maxwell points out that there has been much debate about whether the terms 'reliability' and 'validity', which are commonly associated with quantitative research, can be transferred to qualitative research. According to Maxwell, qualitative researchers have generally responded to questions about the validity of their findings by either denying the applicability of terms associated with the positivist paradigm to their work, or by claiming that qualitative researchers approach the issues of reliability and validity in different ways to quantitative researchers. For example, one qualitative researcher claims that "*While issues of validity and reliability apply to both quantitative and qualitative work, they are conceived of and arrived at in different ways*" (Ely, 1991, p. 94). Some qualitative researchers called for a unitary concept of validity, instead of the different types of validity (e.g. internal validity and external validity) used when evaluating findings from quantitative research. The call for a unitary concept of validity was not widely accepted by qualitative researchers. Rather, qualitative researchers like Guba and Lincoln (1983) introduced analogous terms for the traditional types of validity, for example, 'credibility' instead of 'internal validity' and 'transferability' instead of external validity. These researchers felt that the analogous terms better captured the essence of what is important to them in determining whether research has been carried out fairly and that the research findings closely represent the reality of the situation being studied. The analogous terms introduced by Guba and Lincoln were subsequently used by a number of other qualitative researchers, including Ely (1991), Mertens (2005), Miles and Huberman (1994), and Zhang and Wildemuth (2005). Recently, however, research methodology textbook authors such as McMillan and Schumacher (2010), and Creswell (2012) have steered away from using any of the analogous terms in relation to the validity of qualitative research, citing the different names used by different qualitative researchers for different types of validity as problematic. McMillan and Schumacher use the general term 'validity' to evaluate qualitative research findings. In keeping with this recent approach and Maxwell's assertion that "*Validity is not an inherent property of a particular method, but pertains to the data, accounts, or conclusions reached by using that method in a particular context for a particular purpose*" (Maxwell,

1992, p. 284), I will use the terms 'reliability' and 'validity' to describe improving the trustworthiness of my findings.

3.4.1 Improving the generalisibility of the study

One of the measures of the usefulness of a study is the extent to which the findings of the study can be generalised to other situations, so that lessons can be learned by other researchers and educational practitioners (Fraenkel et al., 2012; Guba & Lincoln, 1983; Marshall & Rossman, 1989; Mertens, 2005). As already discussed earlier in this chapter, case studies typically focus on an intensive study of a single situation, often with a small number of participants, thus making it difficult to generalise or transfer the findings to other situations (Cohen et al., 2000; Silverman, 2004). There are different ways to deal with the problem of limited transferability of single-site case studies. One way is to transfer the burden of transferring findings from a case study to the reader: the reader must compare the similarities between the case study and their situation. Fraenkel et al. (2012, p. 437) point out it is the reader who then "*determines whether the researcher's findings fit his or her situation".* To facilitate this comparison by readers of a study, the researcher must describe the setting and interactions of the study as fully as possible using 'thick description'. The phrase 'thick description', first used by Geertz in 1973, is widely used in qualitative research (Maxwell, 1992). Mertens (2005, p. 256) describes "*thick description*" as an "*extensive and careful description of the time, place, context, and culture of the interactions in a social setting*". The use of thick description is intended to provide readers with more detail of the case study setting to facilitate a comparison with their own situation. In this study thick description was used when recording the observations in the researcher's log (see pages 75-77). Furthermore, detailed descriptions are provided when discussing both methods and results, to help readers decide whether or not to generalise, and which aspects of the study they can do this for.

3.4.2 Improving the reliability of the study

'Reliability' refers to the consistency of the findings for a study (Creswell, 2012; Fraenkel et al., 2012). That is, the findings should be stable, independent of the instrument being used or the person administering the instrument (Creswell, 2012; Krippendorf, 2013). I used a number of methods to enhance the consistency of my findings:

- **Prolonged engagement in the field.** Fraenkel et al. (2012, p. 459) believe that remaining in the field for a long period of time contributes to greater "*consistency over time with regard to what researchers are seeing or hearing".* There is no generally suggested time period in which case study work should be carried out. The duration of the data collection period depends on the specific research questions, the methods of data collection and the time the researcher has available (Ely, 1991). In this study I collected data for the investigation of the factors affecting teachers' use of computers in the school over four years (two years during the first phase and two years during the second phase). I thought this time period sufficient within the context of the study because it included a number of important events which were crucial to the area of research and which I had to understand well to be able to address the research questions. The first of the events was an increase in the availability of computer technologies in the school

throughout the duration of the study. The number and types of computer technologies available for learner and staff use increased significantly over the four-year data collection period. The second important event was the introduction of the Further Education and Training phase of the new school curriculum, with new curriculum requirements which teachers had to implement. The four-year period provided me with sufficient insight to be able to address the research questions.

- **Recording personal thoughts during observations.** I recorded reflective comments on my observations in my log (as discussed on page 76), which can help to reduce researcher subjectivity. For example, examining my log after it had been completed, I became aware of a bias in favour of teachers tending to use technology in the teaching, which I could then attempt to reduce when analysing the teacher interviews.
- **The use of inter-coder reliability.** All open coding conducted during the study was submitted to an experienced researcher for checking. This included checking
  - the content analysis in Chapter 2 (which involved identifying factors from articles)
  - the coding of the interview transcripts for both phases of the study (which involved independently coding interview transcripts and checking for agreement)
  - the five checklists completed during the software evaluation reported on in Chapters 10, 11, and 12 (which involved the other researcher checking my coding and frequency counts, and my comments for the different software design features).

Unreliable data affect validity and undermine the trustworthiness of research findings (Fraenkel et al., 2012; Krippendorf, 2013). Many of the methods I used to improve the consistency of my findings would contribute to improving the validity of my findings, discussed in the next section.

3.4.3 Improving the validity of the study

Attempts to address the **external** validity of the study have already been discussed in the section on 'generalisability' (see Section 3.4.1). **Internal** validity is a 'measure' of whether a study establishes what it claims to establish. This section deals with efforts to improve the internal validity of the study and therefore the accuracy of inferences drawn from the findings, based on how the findings were established.

Validity is a 'measure' of the trustworthiness of the inferences drawn by researchers about constructs, i.e. theoretical concepts or ideas, identified from the data (Mertens, 2005). Improving the validity or 'truth value' of a study strengthens any inferences drawn by the researcher. In case study research "*much depends on the perspective of the researcher*" (Fraenkel et al., 2012, p. 458). It is therefore important to establish how believable researchers' interpretations of participants' perceptions of social constructs are, to judge how credible are the inferences drawn by the researcher (Mertens, 2005). An essential component of contributing to the 'truth value' of the researcher's inferences is the validity of the instruments used to gather data from which inferences will be drawn. According to Anastasi

(1988), instrument validity relates to how well instruments measure what they have been designed to measure. I used the following methods to improve the validity for this study:

- **Persistent observation**. This method of improving validity suggests ongoing and thorough observation is essential so that researchers can evaluate what the features of the main issues for the study are. Cohen et al. believe the value of persistent observation to lie in "*establish(ing) the relevance of the characteristics for the focus*" of research studies (Cohen et al., 2000, p. 108). For this study I attempted to carry out persistent observation by being alert to and aware of issues relating to computers and computer technology in the school during the data collection period, by attempting to clarify issues relating to the use of computers with key role players where necessary, and by attempting to record observed events as fully as possible (even details that seemed irrelevant at the time) as soon as possible after they occurred. All of these activities helped me focus on what made up the features of what Ely (1991, p. 96) refer to as the "*big issues*", viz. the focal points of the research. In Phase 1 of the study, being a teacher at the school meant I was a participant observer immersed in the situation, and thus able to make continuous observations of what was happening, and could talk to the participants about what was happening.
- **Prolonged engagement in the field.** According to Ely (1991), prolonged engagement in the field enhances validity through allowing researchers to better understand what they set out to study, and improving the credibility of the inferences made. As previously stated, I spent four years collecting data, which allowed me to gain sufficient insight to be able to confidently address the research questions.
- **Face validation**. Instruments to be used are often presented to an expert in the field for what is known as 'face validation' (Creswell, 2012; McMillan & Schumacher, 2010). As pointed out by Sanders and Mokuku (1994), face validation is not a type of validation, but rather a method for establishing validity. Fraenkel et al. (2012) emphasise the importance of using someone for face validation who can 'intelligently judge' the content and format of instruments. In this study all instruments [questionnaires, interview schedules, and checklists used to evaluate the multimedia software package (see Chapter 5)] and the coding systems developed for coding the interviews were face validated by an expert – a university researcher with many years of experience in educational research and the use of technology for teaching and learning. The expert checked the language used in the wording of items (to avoid ambiguity), the clarity of the instructions, whether the items included in the instruments were arranged in a logical sequence, the comprehensiveness of the content, and whether the instruments were likely to elicit the data needed to answer the research questions. In the case of the online questionnaires administered to teachers, the layout of the questionnaires was also checked, because, as pointed out by Fraenkel et al. (2012), this could influence how easy it is for respondents to read the questions.
- **Triangulation.** Triangulation involves a comparison of data obtained by different methods of data collection or multiple sources of data to check the validity (truth value) of research findings (Creswell, 2012; Guba & Lincoln, 1983; Mertens, 2005). Where the findings from two or more different research methods used to measure a construct agree, this improves the chances that

the researcher has correctly identified that construct (convergent validity). Using more than one method to collect data allows for the use of convergent validation to improve construct validity (Johnson & Ongwuebuzie, 2004). Greene et al. describe triangulation as follows:

> *The core premise of triangulation as a design strategy is that all methods have inherent biases and limitations, so use of only one method to assess a given phenomenon will inevitably yield biased and limited results. However, when two or more methods that have offsetting biases are used to assess a given phenomenon, and the results of these methods converge or corroborate one another, then the validity of inquiry findings is enhanced.* (Greene et al., 1989, p. 256)

In **quantitative** studies establishing convergent validity usually involves a correlation calculation. Mathison (1988) points out that convergent validity can also be used in **qualitative** studies, by comparing findings using non-mathematical methods. She also points out that when results do NOT converge when triangulated, the researcher should explain apparent discrepancies. Other researchers (e.g. Mama & Hennessy, 2013) have used convergent validity on qualitative data, as has been done in my study. In the first phase of the study I used data recorded in my log and teacher interviews to establish convergence of the research findings from different data collection methods. In the second phase findings from the questionnaires were checked when conducting interviews with teachers.

- **Member checking**. Another method of improving construct validity is for researchers to check their interpretations of accounts with research participants (McMillan & Schumacher, 2010). Wherever I was unsure about something I had interpreted from an interview, I checked with the respondent to ensure the accuracy of what I had heard, and to check my interpretation of what the teacher had said.

Having presented evidence of my attempts to improve the reliability and validity of this study, Table 6 (see next page) presents further evidence of the methods I used to improve rigour and contribute to the trustworthiness of my findings. In Table 6 I have summarised ten standards for judging rigour in case studies, based on Marshall and Rossman (1989) and have shown how the design of this study attempted to address these ten standards, and improve the trustworthiness of the study.

Table 6. Summary of ten standards for judging rigour in case studies (based on Marshall & Rossman, 1989) **and how these have been met in this study**

Standard for judging rigour	How standard has been met in this study
The research should be placed within a clear theoretical framework.	Each of the two aspects of the study has been placed within a theoretical framework (see Chapter 2 for the theoretical framework for the investigation of the factors affecting teachers' use of ICT and Chapter 5 for the theoretical framework for the software evaluation).
Data collection methods must be explicit.	Methods for data collection have been fully described for the investigation of the factors affecting teachers' use of ICT [see Chapter 3 (Phase 1) and Chapter 6 (Phase 2)] and Chapter 5 for the software evaluation aspect of the study.
The truthfulness of participants must be assessed.	The truthfulness of participants has been assessed by looking for convergence of data between the observations recorded in the researcher's log, data collected using online questionnaires and the interviews conducted with teachers.
Data are used to support analytical constructs.	Recordings from the researcher's log, interview transcripts (and data from the qualitative checklists used in the software evaluation aspect of the study (see Chapter 5) have been used to support the researcher's claims. Quantitative data from the online questionnaires used in Phase 2 of the study have also been presented (see Chapter 7).
There must be evidence that negative findings have been explored and accounted for.	The data has been carefully examined to identify negative findings. A negative finding is one which deviates from the expected findings. Where such cases have been found they have been highlighted and accounted for.
Possible sources of observer bias must be addressed.	I acknowledge a bias in this study in favour of the teachers attempting to use technology in their teaching. All findings have been scrutinised to minimise the effect of this bias.
Data collection and analysis methods must be made public.	Methods used for data collection and analysis have been fully described. The researcher's log, audio cassettes and transcripts, completed qualitative checklists are either included as appendices or have been securely stored.
Changes to the data collection strategies must be documented.	All such changes have been documented. One example is the change in the method of recording the researcher's log from hand-written to digital format. Another example is the change in data collection strategies between the initial and extended phases of the study, and the increase in the sample size from the initial to the extended phase.
There must be evidence that alternative hypotheses have been explored.	All data has been carefully scrutinised for possible different interpretations before arriving at any conclusions.
Data must be preserved.	I used tape recordings for interviews, which were then transcribed into digital format. All data (including my log) has been transcribed into digital format and has been backed-up on two separate systems in different locations.

3.5 ETHICAL CONSIDERATIONS FOR THE STUDY

McMillan and Schumacher (2010, p. 15) point out that since educational research typically involves human subjects researchers are required to protect the "*rights and welfare of the subjects who participate in a study*". These authors further point out that many institutions have guidelines for

protecting the rights of subjects participating in research studies overseen by these institutions. Approval for the two phases of this study was granted by the Human Research Ethics Committee (non-medical) of the University of the Witwatersrand (see Appendices J and K) in accordance with the ethics requirements stipulated by the university.

The literature on ethics emphasises the importance of guaranteeing participants' confidentiality. McMillan and Schumacher (2010, p. 339) explain that guaranteeing confidentiality involves protecting participants' "*confidences from other persons in the setting*". Guaranteeing confidentiality represents an undertaking by researchers that any information supplied by participants will be used with discretion and not to "*embarrass or harm them*" (Fraenkel et al., 2012, p. 438). The literature further emphasises the importance of protecting participants' anonymity or privacy, which means that participants' identities will be protected (e.g. their names will not be used in any publication) so that the individual should not be identifiable (Creswell, 2012; McMillan & Schumacher, 2010). According to Fraenkel et al. (2012), where researchers are unable to maintain participants' confidentiality and/ or anonymity, participants should be informed of this and informed or reminded that they can withdraw from the study.

The following ethical considerations were followed during this study:

- **Obtaining permission.** I obtained written permission from the headmaster to carry out the study (see Appendix L). Creswell (2012) believes it is important to obtain such permission as a sign of respect for the site at which the research will be conducted.
- **Informing the participants.** It is important that participants are made fully aware of *"the nature and purpose*" of their involvement in a study, as this reduces the possibility of misunderstandings arising later (Fraenkel et al., 2012, p. 458). Creswell (2012) points out that informing potential participants about the study could potentially display sensitivity on the researcher's part to the time and effort respondents will expend by participating in the research, if these matters are discussed. For each phase of the study I obtained permission from the headmaster to explain to teachers at a staff meeting what my research was about. At this staff meeting I delivered a brief talk outlining the potential usefulness of the study and inviting teachers to participate (see Appendix M. In addition to explaining the nature and purpose of this study at the staff meetings, I also distributed participant information sheets and consent forms (which included permission to tape-record interviews) (see Appendix N and Appendix O for forms for Phase 1 and Phase 2, respectively). The potential interviewees were informed that their participation was voluntary, that they were free to withdraw from the study at any stage and that any information they revealed would be confidential. I also made it clear what participation in the study involved, e.g., for the second phase teachers would be asked to complete a series of online questionnaires and be interviewed, and, possibly, to supply me with copies of tasks they had prepared for *DigiDays* (digital technology days). The participant information sheets included my contact details so that teachers could contact me with any queries or concerns. For the second phase of the study I also supplied the contact details for my research advisor (with her permission) in case I could not be contacted (see Appendix O).

- **Obtaining consent from the participants.** Once teachers were aware of what the study entailed, and their rights, I obtained informed consent forms from potential participants to proceed with the interviews (see Appendix N and Appendix O), as proof that they had agreed to participate in and so that, as Creswell explains, they "*acknowledge the protection of their rights*" (Creswell, 2012, p. 149).

3.6 CONCLUDING REMARKS

This chapter contains a number of important issues relating to the trustworthiness of my study. Firstly, the description of the research design for the study provides evidence of careful planning about how the study will be conducted. Secondly, I provided descriptions of the setting for my case study, my samples, and the different methods used to collect and analyse data during each of the two phases of the study. These descriptions contribute to the rigour of my study. Thirdly, I described the methods used to improve the reliability and validity of the study, and pointed out the ethical considerations I had undertaken. In the next chapter I present the findings for the factors affecting teacher's use of ICT before the innovation promoting the use of technology for instruction was introduced at the school, i.e. during the first phase of the study.