BUILDING CONFIDENCE IN RURAL PHYSICAL SCIENCE LEARNERS USING INFORMATION AND COMMUNICATIONS TECHNOLOGY

by

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DECLARATION

I, Sophy Qhibi, declare that this Mini-Dissertation entitled BUILDING CONFIDENCE IN RURAL PHYSICAL SCIENCE LEARNERS USING INFORMATION AND COMMUNICATIONS TECHNOLOGY is my own work.

____________________________ *14 November 2006*

Signed

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CHAPTER 1:

GENERAL ORIENTATION, CONTEXTUALISATION AND MOTIVATION

1.1 INTRODUCTION

The 21st century is an increasingly computer-driven world, with computers playing a significant role in shopping, banking, industrial operations and a number of other day-to-day tasks. In addition, an important function of computers is the facilitation of communication between individuals worldwide. Educationally, the computer plays a role in making information available for those engaged in research, as well as being an important learning tool at both high and primary school level. As early as 1985, (Kahn, 1985, p19) maintained that computer instructional programmes, such as tutorials and simulation, had the ability to reinforce teaching and learning. More recently, (Feasey, 1994, p73); Ivers (2003); Tomei (2003); Chiazzese (2005); and Beyth-Maroma, Saporta and Caspi (2005), note the importance of Information and Communication Technology (ICT) in education, by pointing out that it makes information accessible to all learners and allows for individualization of learning.

However, not all authors view the growing use of computers as wholly positive. Wan and Gunstone (2003), and Holmboe and Scott (2005) argue that attitudes displayed by both educators and learners towards computers in some cases impacts negatively on the integration of ICT in teaching and learning. For instance, the growth of ICT must also be measured against the context of social, economic and political change in a country. South Africa, after 1994, realized new opportunities for development in education, including the implementation of Outcomes Based Education (OBE) and the integration of ICT on a larger scale. The former Minister of Education, Asmal (2003), stressed the necessity for empowering teachers to use new technologies, which would in turn enrich their teaching and make learning more interesting. National Policy documents now state that all educators and learners should also become educators and learners of ICT.

This belief was part of government policy, in turn leading to the introduction of ICT in many primary and high schools countrywide, with the Government investing in this initiative as well as offering training programmes for educators to become skilled at teaching using technology. Although the implementation of ICT in rural areas in South Africa was in many cases delayed by lack of infrastructure and resources, including electricity and hardware (Herselman, 2003), since 2000 ICT has been introduced and implemented in some rural areas. The government has installed a number of computers and educators are currently undergoing training in former colleges of education in various programmes, such as those offered by Intel. It appears from initial observations that ICT is laden with opportunities for teaching and learning at many levels and in many learning areas. One such learning area where ICT has an important role to play is in the teaching of Physical Science.

The teaching and learning of Physical Science should improve the way learners explore and study the world around them (Ebenezer & Haggerty, 1999, p7). One method used to increase the ability to explore the world is to connect the investigation to the learners' immediate life world, which Ebenezer and Haggerty (1999, p8) put into perspective by reinforcing the idea that teaching and learning of Physical Science in secondary schools should be relevant to the learners' real world. The teaching and learning of Physical Science should also include problem solving (Watts, 1991, p16), where learners acquire new skills, for use in solving problems in similar situations and contexts within their immediate society.

Experimentation, where real experience is brought to learners by exposing them to concrete experiences, can also be used to develop Physical Science learning. The learner-centred approach has been argued for many decades. Kahle (1979) claimed that the teaching and learning of Physical Science should be largely in the form of inquiry, and I argue further that it should be characterized by the learner-centred approach and move away from learners sitting passively in class as receivers of information, to searching for information, inquiring, experimenting, solving problems and applying their skills.

Their and Davis (2001, p9) believe that the teaching and learning of Physical Science is “beyond hands on”, and, as noted above, in high schools it differs greatly from other learning areas. However, my initial literature review also indicates that irrespective of different strategies employed by teachers to teach Physical Science at high school level, many learners have no confidence in the subject (Francis & Greer, 2001 and Parkinson, Hendley, Tanner & Stables, 1998). Although the majority of learners are aware of the importance of Physical Science, few see it as an area of study that they would wish to pursue in Grade 10 and onwards.

1.2 RATIONALE FOR THE STUDY

Physical Science, as taught at schools, can be integrated with other learning areas, such as Technology and Mathematics. One problem that contributes to learners opting to choose other learning areas in place of Physical Science is the shortage of qualified Physical Science educators, especially in the rural areas (Jacobs, 2002). It is also difficult for teachers to make Physical Science appealing to learners who have no confidence in the subject, especially if they do not first have the necessary resources. De Beer and Greebe (2001) confirm by indicating that in South Africa there are only 3.3 scientists per 1000 of the population. The school under investigation has only two qualified Physical Science educators.

Many Physical Science educators expect learners to be enthusiastic about Physical Science, and would like them to have the ability to solve scientific problems. Whilst this is a worthy expectation, there is an inconsistency between the educators’ expectations and the real classroom situation. From personal experience in the rural schools where I teach, classroom activities are dull and lack the capability to affect the learners' confidence in Physical Science. In the previous decade, Lovgren, (1993), Sumerix, (1994) and Hach, (1996) documented that hands-on activities improved learners' confidence and attitude towards Physical Science at high school level. More recently, Watson (2003) and Holzer (2004) emphasized that an inquiry-based approach provided students with a lifelong method of exploring and learning about Physical Science. Learning by doing is more effective than the traditional way of teaching, where learners sat and listened to the educator (Jenkins, 1989). Laboratory teaching, as a method of Physical Science teaching - specifically chemistry teaching - reflects the importance of practical work that should be conducted by learners themselves (Jenkins, 1989). Laboratory teaching is, however, expensive and only a few high schools can afford the facility. Many high schools in disadvantaged rural areas have no laboratories at all and so a hands-on approach is difficult.

In the circuit where the school under investigation exists, there are 9 high schools, not all of which have the relevant equipment for effective teaching of Physical Science. The table below indicates the type of resources and facilities that are found in the high schools within this circuit.

Number of high schools	Library	Science laboratory	Computer laboratory
9	2	2	3

Table 1-1: Types of resources found in high schools within the circuit (from personal enquiries made at schools)

From the table above it is clear that the high schools still need attention in accumulating resources and facilities, especially computers. The other seven schools have one or two computers, but these are used for administrative purposes only.

ICT may be the answer to this problem, as it has the ability to actively involve learners through participation in simulations and other exercises. Linn (2004) confirms that learners need to recognize the potential of the new technology to help them prepare for the future. Unlike the science laboratory, where only a few learners participate in the experiments, ICT has the potential to involve many learners at the same time. Although the introduction of Physical Science material and exercises may increase the interest of high school learners in Physical Science, I question whether it will help in building learner confidence in the field.

1.3 THE RESEARCH QUESTION

Physical Science as a subject has a very small following in the high school in question, and seems to be displaying a gradual decrease in numbers. At present, only 35 learners are studying Physical Science at the Grade 10 level at the selected school. Below I provide the statistics of learners who have enrolled for Physical Science in Grade 10 for the past 6 years at the school where I teach.

Year	Total Grade 10 enrolment	Enrolment of Grade 10 Physical Science learners
2001	144	28
2002	149	36
2003	153	33
2004	142	30
2005	156	15
2006	162	35

Table 1-2: Grade 10 Physical Science enrolment 2001-2006 (school records)

As seen in table 1.1, general interest in the subject is low, and compared to rise in the total number of enrolments, Physical Science enrolments are also on the decline. The lack of exposure to emerging technologies may be a possible cause and an indicator of learners' inability to cope. The following research question arises: **How do rural learners experience Physical Science presented using**

Information and Communication Technology (ICT), and how does this relate to their confidence in the subject?

In order to address the main research question, it is necessary to answer the following secondary questions:

i. What does the literature reveal about learners' confidence in Physical Science at high school level?
ii. What does the literature indicate about the use of Information and Communication Technology (ICT) in the teaching of Physical Science?
iii. How do selected Grade 10 learners at a rural school describe their confidence in Physical Science and their experiences of using ICT in Physical Science lessons?

1.3.1 AIMS AND OBJECTIVES OF THE STUDY

The main aim of this inquiry is to determine how rural learners experience Physical Science presented using Information and Communication Technology (ICT) and how this relates to their confidence in the subject.

In order to achieve the main aim as stated above, it is necessary to state the following objectives:

i. To conduct a literature review on learners' confidence in Physical Science in general.
ii. To document the effectiveness of ICT in the teaching of Physical Science based on documented literature while integrating the theories that underpin the use of ICT in the teaching of Physical Science.
iii. To find out from the empirical component of this inquiry how selected Grade 10 learners at a rural school describe their confidence in Physical Science and their experiences in using ICT in Physical Science lessons.

1.3.2 ABBREVIATED RESEARCH DESIGN

A brief description of the research design follows below. A full description of the research design of the study is found in Chapter 3. This qualitative study can be seen as a generic, qualitative case study (Merriam, 1998 and 2002). Leedy and Ormord (2001) point out that a case study design is employed to gain an in-depth understanding of the situation and meaning for those involved for a definite period of time. Smith (as cited in Henning, Van Rensburg & Smit, 2004) indicates that a case study is distinguished by having intensive description and analyses in a bounded system. The bounded system in my case study is one high school in Bushbuckridge, where interacted with 35 Grade 10 Physical Science learners. The study took place in their classrooms, while they used Physical Science software as well as tutorials, to be downloaded from the Internet. This was conducted in order to gain an in-depth understanding of how computers could build confidence in Grade 10 learners studying Physical Science and how they experience the use of computers. The research design is applicable to the research question in this inquiry and aims to assess the learners' confidence in Physical Science when exposed to emerging technologies within a very specific and well-defined context.

1.3.3 Data Collection Techniques

The instruments designed for data collection enable researchers to gather data, which is uniform, and can be compared and analysed. The following methods for data collection were used in this inquiry.

1.3.3.1 Observation

The first phase was observing learners while they used the selected Physical Science software and Physical Science tutorials, which were downloaded from the Internet. Data from the participant observation method was collected in the form of actions, which included language, as well as more subtle cues such as facial expressions, gestures, tone of voice and other un-verbalized social interactions, which suggested tacit meanings.

1.3.3.2 Structured interviews

Qualitative data was also collected through focus group interviews (Morgan, 1997; Rubin & Rubin, 2005) with selected Grade 10 learners. According to Baker (as cited in Henning et al., 2004, p56) in discursively oriented interviews, respondents interact with the interviewer in a social way. Discursively oriented interviews were conducted with 7 Grade 10 Physical Science learners to determine their perceived change in confidence in Physical Science. Then, I interviewed 7 of the 35 participating group in one focus group interview to discuss the use of computers in the teaching of Physical Science. I made sure that the physical environment was optimally geared as indicated in Henning et al. (2004, p74) by having two tape recorders and a notebook available for record keeping purposes. Any relevant data from the interviews was used to supplement the data obtained from observation.

1.3.4 Data Analysis

Data from the observation was used to support data from interviews which was transcribed into text form. Lee and Fielding (2004, p533) suggest that qualitative data from field sources such as interviews are rendered into textual form by transcription. This data was analysed by using simple content analysis (Strauss & Corbin, 1990 and 1998). In this process data was coded into small units of meaning and categorised according to related codes as suggested by Merriam (1998).

1.3.5 Compliance with ethical standards

Permission was also requested from the circuit office and the school manager of the school under investigation. The participants' ages range between 15 and 17 and consent from the parents was requested in the form of a letter. All of these documents were added to the mini-dissertation in the appendices. The full information on how the study is to be conducted was also explained in face-to-face with the consenting participants. The interview was recorded on tape and the researcher undertakes to store the tape/s of the interview in a locked facility. The research participants were informed that participation in the study is voluntary and that they could withdraw from it at any time. The research participants were at all times informed of the research process and purposes. Participants were also assured that they would not be put at risk or any form of harm due to their participation in this study. All information gathered from the participants was regarded as confidential and anonymous at all times. Research participants were informed that they are free to respond in any language in which they feel competent and translations were done if necessary. Participants were given feedback of the research in a written form. Each participant I received a letter addressed to him/her explaining the outcome of the research in general. Participants benefited by becoming acquainted with the use of ICT in learning. They gained knowledge of doing research, which may prepare them for their studies at Higher Institutions of education.

1.3.6 Reliability, validity and triangulation

Stake (as cited in Tellis, 1997) indicates that validity could be assured in an inquiry such as this by triangulation of data and triangulation of method. Multiple sources of data from the sources mentioned above were, therefore, be used in this inquiry to ensure trustworthiness. I employed methodological triangulation (since I collected two forms of data: observations and an interview). According to Kvale (as cited in Henning et al, 2004), “validity in research depends on good craftsmanship, investigation, continual checking, questioning and theoretical interpretation of the findings”. In this study, the researcher checked, questioned and interpreted the data collected several times.

1.4 SUMMARY OF THE CHAPTER

Chapter one presented background information about the widespread use of ICT in the world, particularly in the education sector. The problem associated with confidence of South African Grade 10 Physical Science learners in using ICT was presented and formulated as the research question for this research. The rationale and the aims of the study were outlined, followed by the research design and methods to be used in conducting the study,

1.5 PLAN OF STUDY

The remaining chapters of this study will be as follows:

CHAPTER 2 reviews the literature on learners' confidence in Physical Science, the use of ICT in the teaching of Physical Science as well as integrating the theories underpinning the use of ICT in the teaching of Physical Science. CHAPTER 3 discusses the research approach, the research design and the methodology of the study, giving a description of the tools used to collect and analyze data. CHAPTER 4 is devoted to interpreting the data and presenting the findings of the study. Finally, CHAPTER 5 contains an overview of the study, draws conclusions, takes into account the limitations and presents recommendations.

CHAPTER 2:

LITERATURE REVIEW

2.1 INTRODUCTION

In the previous chapter the research was conceptualized. The focus of this chapter is to review the literature about learners' confidence in Physical Science and the use of Information and Communication Technology (ICT) in the teaching and learning of Physical Science at high school level. It also defines Physical Science, the aims of teaching it as well as the curriculum for the learning area. The literature will help provide me with a conceptual framework to contextualize my study (Henning, van Rensburg & Smit, 2004, p27).

As the world of ICT has advanced rapidly, its use has expanded globally and into many sectors. There is a growing body of evidence, which demonstrates that educationally it plays a vital role. For instance, Forcier (1999) points out that ICT in education is used as a learner-centered instruction, while Wellington (2004) explains that different software, such as simulations, could be used to make teaching and learning of Physical Science more meaningful. Reviewing the work of such authors further, the main concern in this chapter is to explore the ways in which ICT could be incorporated in the teaching of Physical Science and how it can build confidence in learners studying the learning area. Confidence is a neglected aspect in the teaching of Physical Science, despite its importance. Learners tend to choose other learning areas and avoid Physical Science, because they experience that it is difficult and they have no confidence in the learning area, or in the performance of activities related to the learning area. They may also be intimidated by the high failure rate of Grade 12 Physical Science learners in some schools.

In this section, my argument will unfold in two main stages: Firstly, in reviewing the literature it is important to look at what Physical Science means and what makes the teaching of this learning area differ from that of other learning areas. Secondly, it will expand on why learners have little or no confidence in Physical Science and what can ICT offer towards its teaching and learning, while integrating the learning theories. This section emphasizes the compatibilities, commonalities and blurred boundaries between theories, thereby putting forward an argument that supports the study of building confidence through the use of ICT in the teaching and learning of Physical Science at high school level.

2.2 DEFINING PHYSICAL SCIENCE

In exploring the teaching of Physical Science, a logical starting point in this review would be to define what is meant by ‘Physical Science’ and to highlight how its teaching is unique when compared to the teaching of other learning areas. Physical Science can be defined as “the search to understand the natural world through observation, codifying and testing ideas” (Department of Education, 2002). It has a characteristic of making precise statements, which await proof of some sort. Furthermore, Physical Science is a practical subject, with learners engaging in investigations, observations, discussions and monitoring, and recording results. Although Physical Science involves practical work, it also involves thinking, hypotheses and inference. Wellington (2004) points out that Physical science have a unique content, which embraces theories and laws, and uses vocabulary that may be esoteric.

> *I would almost contend that if something fits in with common sense it almost certainly isn't science. The reason again, is that the way in which the universe works is not the way in which common sense works: the two are not congruent* (Wolpert, 1992, p11).

If the learner’s understanding of specialized language is poor, the newly acquired Physical Science vocabulary will not develop meaning. In addition, Physical

Science deals with processes and learning that make learners aware of conflicts and inconsistence in thinking. Instructional strategies that could make learners aware of conflicts and inconsistencies in their thinking include modelling, scaffolding, problem solving, authentic learning and cognitive flexibility (Tallal, Michael, Merzenich, Miller & Jenkins 1998 and Wellington, & Osborne, 2001).

2.3 THE PHYSICAL SCIENCE CURRICULUM

According to Christensen (2006), a curriculum is a defined and prescribed course of studies, which students must fulfil in order to pass a certain level of education. Curriculum has two divisions, the first being what to teach (content) and the second, how to teach (method) (Turner & Baker, 2002). From the definitions above, curriculum embraces the instructional strategies, assessment and content. In the context of the Revised National Curriculum Statement (Department of Education, 2002) for Natural Sciences, the Physical Science content and knowledge to be taught involves matter and its physical changes, for example, melting and evaporation, acids and bases, chemical reaction, waves, atoms and electricity. The outcomes for teaching this learning area are that learners should be able to perform scientific investigations and construct scientific knowledge, as well as to understand the interrelationships between Physical Science, society, the environment and sustainable uses of resources.

Although the curriculum is undergoing transformation, the teaching of the learning area does not prepare learners to become scientists, but rather teaches them about science. The curriculum is in need of teaching that promotes application of concepts (Pawloski, 1996). One of the aims of teaching the learning area is to equip learners with skills that will enable them to interpret and apply scientific knowledge. The RNCS is being implemented in South Africa, with the aim to transform the situation from one where many people who studied Physical Science could not apply the scientific concepts to solving problems of their everyday lives.

However, many schools in rural areas have no necessary equipment to present Physical Science in a more meaningful way. De Beer and Greebe (2001) indicate that many South African schools have a shortage of facilities to present science meaningfully. Jacobs (2002) points out the large amount of money needed to buy laboratory equipment in order to make the implementation of Outcomes-Based Education (OBE) and the RNCS more functional.

2.4 THE PHYSICAL SCIENCE EDUCATOR AND LEARNER CONFIDENCE

Confidence is the key ingredient for success in all types of learning. Literature reveals that research into the study of learners' confidence in Physical Science at high school level still needs serious attention (Keeves & Morgenstern, 1992). Lack of confidence impacts on the learners' participation in the learning area (Rampa, 1996) and impacts on his/her academic performance in science, in particular their choice of science related career (Moffat, 1992).

There are numerous factors that cause learners to have little confidence in the learning area. An educator who has no relevant skills to actively involve learners in his/her teaching of the learning area could lead to a lack of confidence amongst most learners. Misconceptions attached to Physical Science are another cause of lack of confidence in learners, with the learning area labelled as difficult. A high failure rate in Grade 12 learners does little to boost confidence in the learning area. Anxiety and language development also contribute to this lack of confidence. Mashike, (2000) indicates that when the level of language development is insufficient it impacts learners' understanding of the concepts.

2.4.1 The Physical Science educator

The Physical Science educator must first satisfy the ingredients of motivation, dedication and communication, so that he/she can motivate and encourage the learners to approach the subject without prejudice of labeling it as a difficult subject. An ideal Physical Science educator must have a genuine interest in Physical Science and be able to develop a professional model that promotes reflection upon practice and collaborative dialogue (Shepardson, 2001). In order to influence learners positively, and build their confidence towards the learning area, the educator must have full awareness of scientific knowledge and an ability to integrate this knowledge across the curriculum. S/he must be aware of the wide variety of resources, including books, films, laboratory equipment and ICT resources, used on a daily basis within the immediate environment of the learner. In the revised national curriculum statement, the Department of Education (2002) indicates that the country envisages educators who are qualified, competent, dedicated and caring. An ideal Physical Science educator, who meets all the qualities above, will therefore have a sound knowledge of how to interpret the Physical Science curriculum in order to achieve the aims of OBE, as well as the outcomes for teaching Physical Science.

OBE regards learning as an interactive process between educators and learners, with the aim of actively involving learners into their learning while inculcating lifelong learning by encouraging learners to seek for knowledge. According to Spady (1993), the desired outcomes are selected first, followed by the curriculum, instructional materials and assessments.

2.4.2 The Physical Science educator’s role in alleviating anxiety

Learners who lack confidence in Physical Science display anxiety in a variety of ways. According to Young (1995), different categories of anxiety exist amongst learners. To name a few, these are: danger anxiety, test anxiety, problem solving anxiety, performance anxiety and classroom anxiety. The context in which learning takes place may sometimes causes anxiety amongst learners (Segal & Cosgrove, 1992; Tharp & Gallimore; 1991). When individuals are exposed to a new task they are often frightened by the context in which they perform the tasks (Magagula, 2005), and so the level of anxiety rises. Learners are afraid of failure to perform the task correctly (William, 2002). Learners who feel threatened by Physical Science start to avoid it.

One context, which may bring about anxiety, is the laboratory. Learners tend to avoid performing experiments in the laboratory due to the fear of failure. Anxiety in Physical Science appears to be affecting learners' participation in the learning area and impacting on their performance (Tharp & Gallimore; 1991). In a study conducted with one thousand high school learners, Wyustra and Cummings (1993) aimed to find out why most high school learners are intimidated by Physical Science. The outcome of the research is that learners had test anxiety and classroom anxiety. Similarly, Ashcraft and Kirk (2001) found that students with a high level of maths anxiety enrolled in fewer math courses

The Physical Science educator should create a learning environment, which stimulates learners' interest in the learning area. Learning environments that stimulates learners' interest can be created by learning experience that includes opportunities for group work, individual work, discussion amongst learners and educator, as well as hands-on and minds-on activities (Morrison, Ross & Kemp, 2001). These will help learners to construct their own knowledge (Jonassen, 2003). When learners are given an opportunity to write and communicate, as a way of learning, it could be another way of creating interesting learning environments. An educator could let learners describe processes and express their understanding in the form of writing. Computers could be used in many forms of writing, for instance with learners creating web sites, tables, graphs and diagrams related to the topic they have learned (Alessi & Trollip, 2001; Jonassen, 2003).

The writing of tests is one of the anxieties that most learners are faced with. The use of different assessment techniques could combat test anxiety. Continuous assessment is taken as a better method of assessing in South Africa (Department of Education, 2002; Gummer & Shepardson, 2001). In continuous assessment, learners perform different tasks, such as investigations, reporting and design projects, with the aim of developing certain skills needed for learners to cope with the learning area (Shepardson & Britsch, 2001). Previously, assessment consisted of assigning a mark to the piece of work, which, depending on whether the learner passed or failed, could cause, anxiety. One of the advantages of continuous assessment (Department of Education, 2002) is the use of rubrics to score learners' performance. A rubric guides the educator in assigning points to certain areas depending on the level of competence shown by the learner. This tends to reduce the anxiety of failure and in addition the educator's comments support the learner in firstly, identifying areas of weakness and secondly, guiding the learner when revising.

2.4.3 The role of the Physical Science educator in alleviating concerns and misconceptions related to Physical Science

Although this study is not about misconceptions, it is imperative that it is explored in this section because it affects the learner's confidence in Physical Science. The first 'misconception' is the belief that Physical Science is a difficult subject. Despite equal opportunities for all learners in Physical Science, the misconception still stands. Research concerning misconceptions confirms that it impacts on learners' confidence in the learning area (Kahle & Meece, 1994). It is also the main reason there are fewer learners in the science classes (Postma, 1994, as quoted by Jacobs, 2002, p22). Lack of confidence in Physical Science leads learners to avoid it and those who opt to study it may be vulnerable to becoming victims of failure. A correlation exists between confidence and academic success, and researchers such as Linn (1992) indicate that there is a close relationship between confidence in the subject and academic achievement of the learner. Mickelson (1990) indicates those learners with negative attitude and less confidence have learning problems, which cause them to perform poorly in their Physical Science academic tasks.

The Physical Science educator should assure all learners entering the Physical Science classroom that although the learning area is challenging, it is not as difficult as it may be perceived. This assurance could be maintained by creating a learning environment where learners are encouraged to acquire knowledge and develop skills that allow them to apply scientific principles in real life situations. Jacobs (2002, p22) reinforces this idea by explaining that the teaching of all science subjects could be improved by making them more accessible to learners and by teaching learners to apply scientific knowledge. She goes on to advocate the use of different learning tasks, with quality instructions and characteristics, such as pre-knowledge and learning styles. Motivation is another good way of changing the misconceptions, and Turner (1995) indicates that intrinsic motivation makes learning more enjoyable. To help motivate the learners intrinsically, the educator should present the lessons in an interesting way. One way of presenting lessons in an interesting way is by moving away from the traditional way of teaching and instead employing different strategies to teach the learning area. The educator should bring to the object being studied the learning experience that involves all the senses and emotions, so as to motivate learners. The educator could, for example, use multimedia, such as videos and simulations for motivational purposes (Alessi & Trollip, 2001).

Linn (2004, p11) states, “effective instruction motivates learners to consider new ideas, sort out their existing ideas and develop the capability of making sense of new information throughout their lives.” However, learners should be critical thinkers in order to sort out the existing information and make sense of the new acquired information. Mashike (2000) contends the importance of teaching learners critical thinking in science subjects. An ideal Physical Science educator should use different techniques to present lessons in more interesting and interactive ways and ICT offers different teaching techniques such as tutorials, which could be used to teach learners to read deeply, think critically, assess themselves and develop confidence in their learning. Another ICT teaching techniques is simulations where learners need to think quickly and critically to participate successfully, which motivates them by actively involving them in their learning (Alessi & Trollip, 2001).

OBE emphasises the necessity of considering all the differences that learners bring to the classroom situation and an aspect that the Physical Science educator should be aware of as differences such as language of communication, pre-knowledge and psychological differences need to be taken into account. Jacobs (2002, p24) indicates that language in South Africa has a detrimental effect because scientific language differs from the languages that the learners use in their different homes. Pre-knowledge is also necessary to build the foundation for all learning. Learners come to school with different pre-knowledge. The educator should also find out what the learners already know in the topic that is to be presented and build new knowledge into the existing one. Computer software can potentially fulfil this role through pre-tests and even keep records of this.

The Physical Science educator should also be an inclusive educator. Information and Communications Technology has the potential to cater for many differences that exist in learners, some of which will now be considered.

2.5 THE USE OF ICT IN THE TEACHING AND LEARNING OF PHYSICAL SCIENCE

Education in South Africa is shifting from teacher-centred instruction to learner-centred activity (Jacobs, 2002, p65). ICT is an instrument that could be used to assist educators to be more learner-centred in their teaching, and address some of the problems that the learners bring to school (Bowers, 1998). The teaching of Physical Science using ICT also faces many challenges. These are, amongst others, the availability of hardware as well as software for its implementation. The use of ICT around the world has raised the important question about its usability in the teaching and learning of Physical Science ICT plays a dynamic role in the teaching and learning of Physical Science by having the ability to furnish visual images of Physical Science ideas, facilitate, organize and analyse data efficiently and accurately. These same standards further call for making Physical Science relevant to learners. When learners make connections between what they studied in class and what they experience in life outside the classroom, they develop more and deeper understanding of the concepts, as well as becoming equipped with opportunities for employment. Wellington (2004) made a point that ICT has the ability to make learners connect classroom activities and the world outside the classroom situation by bringing reality to the learners in the form of content and process.

Boohan (2002) supports Wellington's point of view by indicating that ICT could be used to support learners' reading and writing of Physical Science, as well as the communication of scientific ideas. As indicated in the introduction, one of the aims of this study is to find out how the use of ICT can benefit the teaching and learning of Physical Science. Many researchers, such as Wellington (2004) and Linn (2004), document the application of different ICT programmes benefiting teaching and learning of Physical Science in extensive ways, such as allowing learners to work independently.

However, the question arises as to whether ICT has the ability to motivate learners and develop confidence in their learning. The constructivist perspective theory of learning is characterized by the belief that learners construct their own knowledge rather than receive performed information transmitted by others. Von Glasersfeld, (1989) describes learning as an individual construction of knowledge. According to Mezirow (1994, p223), learning is "the social process of construing and appropriating a new or revised interpretation of the meaning of one's experience as a guide of action." McFadden (2005) argues "constructivist learning provides experiences by which to build science process skills and assist in developing critical thinking, social skills and expository writing practice." On the other hand, von Glasersfeld (1995) tends to shift from a constructivist perspective to situated perspective of learning by viewing learning as the building of knowledge in a particular cultural practice. Wenger (1998) supports the perspective of situation knowledge construction by indicating that learning is dependent on social context. Vygosky (1978), father of social constructivist theory, was one of the first to mention the situated perspective, indicating that: "the influences of cultural and social contexts in learning support a discovery model of learning". The use of ICT software to teach Physical Science in an interesting and interactive manner has the ability to motivate the learners to interact with the various tutorials and thus construct their own knowledge and learning. Jacobs (2002) explains that when learners are actively involved, they are motivated to become active participants more than mere observers, particularly if they work in pairs or groups.

The formation of a Physical Science ICT community of practice may be a way of applying the situated perspective in the learning of Physical Science. Communities of practice share sets of social practices that become differentiated among sub groups. Learning in communities of practice may be in the form of discussions. Jacobs (2002, p68) indicates that classroom communication systems could assist educators with a large number of learners to facilitate the communication. While the learners are busy posting their communications, the educator could learn more about their learners' progress through the shared learning environment.

Learners develop a common understanding through dialogue in the community of practice context. McMahon (2000) argues that learners could work together in self-selected groups and submits their responses in an open forum available to tutors and the whole student course. They also learn to socialise and learn to work as a group, which is one of the critical outcomes for OBE, which is being implemented in South Africa. Furthermore, many learners enjoy learning Physical Science in the community of learners, as they are shy or unable to communicate in the classroom situation. However, the use of community of practice is not applicable in my study because computers are not networked and they are not connected to the Internet. The use of ICT in the teaching of Physical Science that could be applicable to the school under investigation is expanded in the table below.

ICT assists learners to construct knowledge	**ICT as learner-centred instruction**
Word processing Spreadsheets Databases Communication tools	Simulations Tutorials Drills
ICT as both educator and learner-centred instruction	
Assessment Problem solving	

Table 2-1: Presentation of the use of ICT in Physical Science in a matrix (Vels matrix, 2005)

2.5.1 ICT affords learners the opportunity of constructing their own knowledge

ICT, with its plentiful tools of knowledge production provides learners with opportunities to construct their own knowledge. The following applications make the construction of knowledge possible:

2.5.1.1 Word processing

Because word processing has rapidly become a part of people's everyday experiences in life outside the classroom, its use in the Physical Science classroom serves as an excellent means for helping educators meet the relevant objectives. Learners may use word processing to write their findings and reports on the experiments that have been done in the laboratory. According to Wellington (2004), students improve their writing styles when they use word processing and they present eligible work with few spelling mistakes and fewer grammatical errors, because word processing has features that track down some spelling mistakes and some grammatical errors. Furthermore, reports written through word processing can be saved for future references when preparing for examinations.

2.5.1.2 Spreadsheets

Just as spreadsheets play a central role in the teaching of accounting in drawing up an income and expenditure sheet, they can also facilitate learning of Physical Science. A spreadsheet programme stores data so that the numbers can be graphed, and analyzed according to the instructor or educator instruction. It is a practical classroom resource and has the potential to help Physical Science learners to address increasing demands on their time and energy. Spreadsheets, with their unique features of presenting information in tables where rows and columns, are used to identify particular information, with a role to play in the teaching of Physical science. Data experimentation on such topics as current, voltage, resistance and power as part of the Physical Science curriculum could be correlated (Wellington, 2004).

Spreadsheets have the ability to motivate and support learners' activities, particularly when applied to certain areas of the Physical Science curriculum. Linn (2004) confirms the motivational aspect by highlighting that users of spreadsheets spend less time attempting to solve personal problems and more time taking advantage of the power of software. Furthermore, the educator-learner relationship will improve because learners will value the educator for introducing the different new activities in an interesting way through ICT. Learners experience firsthand a series of enjoyable and engaging activities, both important pre-requisite for learning that give them deeper understanding about the Physical Science concepts.

2.5.1.3 Databases

Databases can be helpful in learning topics, such as periodic tables, allowing learners to search through information in a faster, more flexible way. Learners are able to connect and compare one set of figures with another (Wellington, 2004). An example of a Physical Science database (National Institute Standards and Technology Laboratory, 1994) includes atomic physics, electronic and optical physics, time and frequency. When a learner clicks on any topic from the database, it leads to other information relevant to the topic clicked (See the interactive periodic table in Chapter 3).

2.5.1.4 Communication tools

ICT plays an important role in communication, particularly with its most extensive and popular communication tools such as e-mailing, conference rooms and online discussions (both synchronous and asynchronous discussions). These communication tools have the ability to influence collaborative learning. According to Piaget's theory, in order to foster cognitive development, educators should create and organise classroom experiences that challenge learner's thinking. One way of fostering cognitive development is by using communication tools. When learners interact with their peers in this way, they develop cognitively. The use of ICT as a communication tool in teaching and learning will be expanded upon in the following sections.

2.5.2 Computer assisted learning

The use of ICT can assist the educator in various ways. The uses of multimedia approaches in Computer Assisted learning (CAL) have some unique features, presented below.

2.5.2.1 Simulations

The early years of Physical Science teaching at high school level was directed by lecture and demonstration methods (Jenkins, 1989). The lecture method, which emerged from behaviorist theory, has been used for many years in the teaching of Physical Science, and has led to passive learning (Nukeri, 2000). During the nineteenth century, the demonstration method emerged to be better than the lecture method for teaching of Physical Science, although it also has limitations for Physical Science learners. According to Fourie (as cited in Nukeri, 2000), demonstration equips educators with a better understanding of the learner's comprehension and understanding, as discussions and questions will follow immediately after a demonstration. Fourie also highlights the limitations caused by demonstration, pointing out that learners have little opportunity to become familiar with materials, since only a few may help to perform the experiment and those who are not involved may tend to lose interest.

Experimentation and laboratory teaching shaped the teaching of Physical Science for many years in South Africa, and made learning more meaningful. However, learners from rural areas did not have the same level of access to laboratories learning as learners in the urban areas (Muwanga-Zake, 2003; Jennings & Everett (1996), as only 23% of Black schools reportedly had laboratories. Conversely, both experimentation and laboratory teaching have their own limitations and are not attractive to many learners in Physical Science classrooms. Experimentation and laboratory teaching are strategies of teaching Physical Science through engaging learners in conducting experiments in the laboratory context, in order to prove certain scientific statements and reporting on the results of the experiments. Demonstration is a strategy where the educator demonstrates the experiments involving only few learners (Nukeri, 2000). Recently simulation became the most popular and influential software that brought a change in the teaching and learning of Physical Science, specifically to laboratory teaching. The unique interactive character of simulations allows learners to make inputs to the model and affords them the opportunity to be actively involved in their learning.

Some processes are too dangerous to be carried out in the school laboratory, for instance, experiments investigating the reactivity of metals with cold water and metals such as lithium often react more vigorously than expected and are unpredictable. When the experiments are done through computer simulation, the learners are not at risk from dangerous as well as complex situations, such as chemicals that could be intoxicating and extremely dangerous. Allessi and Trollip (2001) confirm the power of simulation by indicating that it can teach some dangerous processes by imitating it.

In addition, simulation is cost effective as there is no need to buy some of the expensive apparatus and materials needed to show the processes and the phenomena in the science laboratories. There are many free simulations, which can be downloaded from the websites at little or no cost. This could benefit many rural high schools, because they do not have science laboratories. Learners have many opportunities for learning through ICT and simulation, as they learn by doing, receive information and refine their understanding on continual bases in order to build new knowledge. This supports the theory of Papert (1980), who maintains that learning not only takes place when learners construct their own knowledge, but do so by holding to their perceived interpretation. Learning through simulation brings about the reality of the concept being simulated, although the contact of the outcome of the experiment in the form of smell loses its benefit. Processes and phenomena, which are too slow or too fast to be carried out in the laboratory, can be shown through simulation. Simulations connect information at a faster rate and save time. Gibbons and Fairweather (1998) and Biggs and Moore (1993) indicate that simulation has the ability to motivate, and bring excitement and pleasure to learners by taking part in the activity, which is one of the ideal features needed in Physical Science classes

The research by Barak (2004) on simulation of electronics indicates that it yielded good results by motivating learners, because they had control of the learning tasks and also influence over laboratory studies. Allessi and Trollip (2001) support the motivational aspect by indicating that simulations are interesting and have the ability to motivate learners. When ICT is integrated into Physical Science classrooms, learning becomes more flexible and less formal. However, Trowbridge and Bybee (1996, p191) argue that experimentation through computer simulation should not replace the traditional laboratory experimentation, as it develops certain skills such as acquisition, organisation, creativity and manipulation. Again, there are serious cases where simulation only is not sufficient for discovery learning. Therefore, paper-based and face-to-face teaching still has significant roles to play in the teaching of Physical Science. This means that when integrating ICT into the teaching of Physical Science, not all the experiments should be done using computer simulation.

2.5.2.2 Tutorials

Tutorials are types of media which have teaching goals set to be achieved at the end of the lesson, and learners are to perform in relation to the goals of the tutorial (Laurillard, 2004). Learners, for example, are to go through different topics using the navigation menus. Tutorial and multimedia software engage learners in meaningful interactive dialogue and creatively employ graphics, sound, and simulations to promote acquisition of facts and skills, promote concept learning, and enhance understanding (Allessi & Trollip, 2001). Jacobs (2002), mentions that in tutorials learners work at their own pace and the computer is non-judgmental. In addition, tutorials may have hyperlinks which link to web pages that have more content that may be limited in the textbooks. The hyperlinks can link learners to the Physical Science expert if they are connected to the Internet. In addition tutorials can also provide instruction to students who have missed classes, to review previously encountered topics, or for remediation (Merrill, Hammons, Vincent, Reynolds, Christensen, & Tolman, 1992).

2.5.2.3 *Drills*

Drills play a significant role in learning of Physical Science. Although it draws on the behaviourist theory of learning, it benefits learning of content, which need repetition, such as scientific laws. This theory focuses on the repetition of new skills or knowledge and provides step-by-step instructions on how to complete a certain objective until it is mastered. Allessi and Trollip (2001) support this by indicating that drills provide practice of information, which need to be mastered. Each time the learner gives the answer, feedback is offered in a very simple way. When the leaner gets the answer correct, the feedback is positive. If the answer is wrong, motivational feedback is given and the exercise continues until the learner gives all the correct answers. Again, Problem solving as one of the instructional strategies that make learners aware of conflict and inconsistencies in their thinking is confirmed by Gagne (1970), who suggested that problem solving can be viewed as a process by which learner discovers the combination of previously learned rule that he/she can apply to achieve a solution for a novel situation. It is also a process that yields new learning.

Learners are often required to recall, comprehend or apply given rules or principles. This type of learning is generally very effective and promotes learning because drill and practice increases learners' acquisition of basic skills, although the cognitive challenge for learners is rather low. Santoro (1995) explains that drills can be used to assist learners to work at their own pace as well as to enable learners to take responsibility of their own learning (Lynch, 2001). More complex materials are needed to encourage higher order thinking skills and in Physical Science, drills can be employed to master names and formulae in a periodic table, as well as for calculation of mass, density and volume. Furthermore, they can be used to practice the structure of atoms.

2.5.3 The effectiveness of computers to both learner and educator

Computers in education have unique features, which could be used by both educators and learners to benefit teaching and learning.

2.5.3.1 ICT and assessment in Physical Science

Literature reviewed assigns a number of roles to assessment. However, it is important for me to first define assessment. According to the RNCS (Department of Education, 2002)

> *"assessment is a continuous, planned process of gathering information about the performance of learners measured against the assessment standards of the learning outcome"* (Department of Education, 2002).

> *"Assessment is an ongoing process aimed at understanding and improving student learning. It involves making expectations explicit and public, setting appropriate criteria and high standards for learning quality, systematically gathering, analysing, and interpreting evidence to determine how well performance matches those expectations and standards; and using the resulting information to document, explain, and improve performance. When it is embedded effectively within larger institutional systems, assessment can help focus collective attention, examine assumptions, and create a shared academic culture dedicated to assuring and improving the quality of higher education"* (Angelo, 1995).

Assessment is very important to different stakeholders such as policy makers, parents and learners. A report from a panel discussion conference held at the British Museum by Langley (2003) pointed out that high stakes testing of Physical Science raises test scores without improving knowledge and understanding and competence evaluations are less beneficial (Wilson, Cordy & Uline, 2004). From my point of view, paper-based assessment, especially the final examinations, contributes towards the less population, for Grade 10 Physical Science classes in most schools. Usually, Grade 9 final examinations results are used to grade learners into different learning areas (subjects) in Grade 10. Because of bad performance in the final examinations for Grade 9 in General Science (Natural

Sciences), some learners capable of doing Physical Science in Grade 10 have less interest in the learning area. I therefore, claim that the exam driven assessment contributes to the lesser number of learners who are studying Physical Science specifically in Grade 10 classes. According to RNCS (Department of Education, 2002), learners are to be assessed continuously. In continuous assessment all learners who performed well through out the year in Grade 9 Physical Science will not be affected by the final examination and will be accommodated in Grade 10 Physical Science classes. The following paragraph suggests ways of improving assessment-using ICT.

Portfolios are becoming popular in today's ways of assessment, as collections of learners' work that exhibit their effort and progress in a learning area. Electronic portfolios are gradually used for assessment in ICT. Sheingold (1992) suggests the advantages of electronic portfolios as making the work more portable, accessible, and more easily widely distribute. Electronic portfolios allow educators to develop and organize the artifacts in many media types, such as video, text and graphics. It uses hypertext links to organize the material and concrete artifacts to proper standards. When electronic portfolios are used for assessment, educators will have minimal storage space. In addition it is easy to create back up files and the file will remain as long shelf life and it is learner-centered.

According to Barett (2000), electronic portfolios can be created as word processing documents, PowerPoint, Adobe Acrobat, web pages and multimedia. There are various software such as Microsoft Access, HyperStudio and Digital Chisel which could be used to develop electronic portfolios. Furthermore, online assessment could be used to give individual learners different tasks in one topic. Bronson (1996) indicates that computer assisted personalised assignment system software produces different homework and assignments for each learner while covering the same concepts. When each learner is given unique assignment, originality is promoted. Each learner is given an opportunity to work according to his/her potential without copying. Although it will seem too much work for the educator, but learners learn from early stage to be original and the copyright issue is inculcated.

2.5.3.2 Suggestions for how the use of ICT could promote collaborative learning in Physical Science

Internet learning is one of the popular ways that is gradually gaining strength of promoting collaborative learning. All individuals involved in collaborative learning are provided with learning resources that are always available anywhere and any time. ICT brings about more resources for the construction of collaborative teaching and learning environment (Jervis & Steeg, 2000). The most influential aspect of e learning is that it promotes collaborative learning. Communication of Physical Science topics through ICT communication tools promotes collaborative learning that is impossible in a traditional classroom situation. Collaboration also supports knowledge integration. “One tenet of scaffold knowledge integration is to allow students to learn from one another” to the object being studied (Hoadley, 2000). For an example in Physical Science learners could be given homework to conduct experiment on heat transmission through conduction, convention and radiation. They could then collaboratively use their findings to create charts or bulletins.

The teaching and learning based on collaborative environment, has the ability to awaken and improve the learners’ creativity. Creativity is a novel and adaptive solutions to problems (Amabile, 1996). Creativity in collaborative learning involves learner-generated questioning and sustained dialogue among learners and between learners and educators. Again, one learner could begin the collaboration of heat transmission in the form of question, which will make the dialogue to flow. ICT has many communication tools, which could be used for collaborative learning. These communication tools are among others e-mails, listservs, bulletin boards, chart rooms, audio teleconference and video teleconference. In addition, collaborative learning promotes self-reflection. In order to promote self-reflection, the learners are given an opportunity to post their new understandings of the topic and any questions they might have relation to the topic and this process provides safe communication for learners. Learners ask questions that they may not ask in the classroom situation. However the opportunity of collaborative learning using the different communication tools will not be possible in my study because the computers are not connected to the Internet.

2.6 SUMMARY OF THE CHAPTER

This chapter highlighted that Physical Science is a difficult subject, a misconception which tends to cause anxiety among learners and even prevents them from choosing to study it further. Anxiety tends to affect learners' participation in classroom activities which is compounded by the lack of qualified science educators particularly in many rural schools.

Educators are responsible for interpreting the curriculum in a way that will influence attitudes towards Physical Science. To alleviate the anxiety, the literature suggests that educators could create a learning environment, which stimulates learners' interest and makes use of group and individual work to construct learning and draws on intrinsic motivation as a weapon of fighting against misconception.

ICT should be seen as playing a vital role in education. This chapter described the use of ICT in the teaching and learning of Physical Science as a means to give learners control of their own learning, to build their confidence, and to alleviate any concerns related to the learning area. The use of computers for teaching takes the form of learner centred instruction and also assists learners in constructing their own knowledge.

The literature reviewed suggests that the behaviourist theories through drills and practice, constructivist and situated theories of learning by means of tutorials and simulations have direct influence on the use of ICT for teaching of Physical Science. However, traditional instructional methods, largely lecture and demonstration, are not effective methods for Physical Science teaching. The widespread acceptance of interactive learning methods through ICT, some of which have been argued in this chapter, demonstrate enhanced learning and motivation for learners.

Collaborative learning shapes the learning of Physical Science, and computers have extensive ways of inculcating this valuable skill. Communication tools, ICT with its different programmes such as simulations, tutorials and drills has been found to be applicable in the teaching of Physical Science motivating and building confidence in learners. Assessment strategies could also incorporate electronic portfolios because they are more portable, accessible, and more easily widely distributed. However, the assumptions and convictions of ICT found to be applicable in learning institutions, in the case of the Grade 10 learners in the school under investigation, await empirical verification.

The following chapter will now deliberate on research design, context of the study, research method and data analysis.

CHAPTER 3

RESEARCH DESIGN

3.1 INTRODUCTION

The previous chapter focused on the reviewing of literature for the study. The literature reviewed revealed the importance of this study by establishing a theoretical framework, which serves as a guideline for comparing other research. This chapter discusses the research design that was used to collect and record data, including participant selection, validity and reliability, as well as the data analysis methods.

Research design is the complete strategy of attack on the central research problem (Leedy & Ormord, 2000, p91). Merriam (1998, p6 and 2002) compares research design to an architectural blue print explaining that research design is a plan for assembling, organizing and integrating data, which results in research findings.

3.2 CONTEXT OF THE STUDY

This study was conducted at one high school, which is located in Bohlabela district of Mpumalanga province in South Africa. Bohlabela district is known as Bushbuckridge and is situated on the border of Limpopo and Mpumalanga and is particularly disadvantaged with many people staying in rural areas. After the first democratic election in 1994, Bohlabela district was governed by Limpopo province, until 2005, when administration was transferred to Mpumalanga province. Below is a map of Mpumalanga province where Bushbuckridge is situated.

Figure 3-1: Map of Mpumalanga province (Online images)

Furthermore, people from two former homelands, which were Gazankulu and Lebowa, occupy the district and it took time to unite the two communities as they were from two different backgrounds and their departments of Education also differed. This situation led to a very slow ICT implementation in many schools in Bohlabela. The high school under investigation is one of the schools that was affected, hence my interest in this study. The school is generally poorly equipped with computers, and is limited to only 10 'unnetworked' computers with only 7 of the computers having CD – ROMs. Learners presently attend computer skills lessons during the afternoon hours.

3.3 PARTICIPANTS

The participants in this study were Grade 10 Physical Science learners from a Bushbuckridge Secondary School. Observation was done during computer-assisted Grade 10 Physical Science lessons. Participants were between the age of 14 and 16 with 14 females and 21 males. I did, however, purposively select seven of the Physical Science learners to take part in the interviews. I selected participants who seemed to be interested in computers and those who seemed less interested in computers. All Physical Science learners agreed to participate in the study and their parents also gave consent for their children to participate in the study.

3.4 RESEARCH PARADIGM

Every researcher works from a specific paradigm, which serves not only as a philosophical framework, but guides their type of research and the design choices available within that particular paradigm. Bogdan and Biklen (1992) define a paradigm as a loose collection of logically held together assumptions, concepts or propositions that orient thinking and research. A paradigm provides general theoretical assumptions which members of a particular scientific community share. The assumptions that people have about the world are their theoretical orientation (Pring, 2000). Therefore, every researcher is guided by some theoretical assumptions. Merriam (1998:4) and Henning et al. (2004, p17) distinguish between three paradigms for educational research: positivist, interpretive, and critical. The paradigm employed in this study is the interpretative paradigm. As researcher, I aim to interpret how learners experience the use of ICT in the teaching of Physical Science.

3.5 RESEARCH APPROACH

Quantitative and qualitative approaches are two major approaches used in research. The debate over qualitative versus quantitative research methodology is viewed not only as a disagreement over relative strengths and weaknesses of both methodologies per se, but rather as a fundamental clash between the two paradigms (Silverman, 2004; Anfara & Mertz, 2006). It is a fact that the two methodologies can perform differently. Data accumulated by the usage of qualitative research is generally more in-depth, textured, and richer while, on the other hand data generated from quantitative research strategies is more generalizable and predictable (Lincoln & Guba, 2003).

Qualitative approaches are classified as non-numeric research while quantitative is classified as numeric research. Keohane, King and Verba (1994, p5) indicate that the differences have been over emphasised by authors but that in some research it is impossible to employ a single approach (See also Bogdan & Biklen, 2003; Biesta & Burbules, 2003). This study used the qualitative research approach. Data was collected in the form of words rather than numbers.

3.6 RESEARCH DESIGN

There are various designs used in the qualitative approach and the design type of this study can be described as a generic, qualitative case study. Merriam (1998, p19), points out that “a case study is employed to gain an in-depth understanding of the situation and meaning for those involved. This design type is believed to be appropriate on the study of the situation to gain more understanding of it. According to Tellis, (1997) case studies have been employed in varied sociological studies. The interest is “in process rather than outcomes, in context rather than a specific variable, in discovery rather than confirmation.” I employed the case study method, to gain an in-depth understanding of the learners’ experience of the use of ICT, and whether it has helped build their confidence and interest during the process of the teaching and learning of Physical Science.

Some researchers such as Stake (2000) take the case study as the object to be studied while other researchers such as Leedy and Ormord (2000) define a case study as “a particular, individual, program, or event studied in depth and for a defined period of time". Furthermore, Henning et al. (2004) indicate that a case study is characterised by boundaries that can be identified. This study falls into the case study research design because it was conducted at one high school in Bushbuckridge within a period of two weeks. The bounded system in my case study includes my collaboration with 35 Grade 10 Physical Science learners while they use Physical Science software as well as tutorials, which were downloaded from the Internet.

I chose a case study design because it involves "detailed, in-depth data collection involving multiple sources of information rich in context" (Creswell, 1998, p61). Context is a key factor. According to Merriam (1998), in focusing on a particular phenomenon in a case study, it is impossible to separate the phenomenon from its context. However, in this study, it is important that the context is understood as part of the process.

Smith (as cited in Henning et al, 2004) indicates that a case study is distinguished by having intensive description and analyses in a bounded system. "Case studies are the preferred strategy when "how" and "why" questions are being posed, when the investigation has little control over events, and when the focus is on a contemporary phenomenon within some real life context" (Yin, 1994, p1). Hence, a generic case study as a qualitative research design is appropriate for this study because it aims to find out how learners experience the use of ICT in the teaching and learning of Physical Science.

3.7 THE CASE

The participants in this research used tutorials found on an Encore software CD (2006) for high school Physical Science. The CD consisted of 8 chapters divided into topics. The topics found in the CD included energy, heat, temperature, sound, electricity, force, atoms and waves and were part of the Grade 10 Physical Science Curriculum (Department of Education, 2003). Learners were required to read the information on the above topics, watch the video, participate in simulations, and complete the calculations as well as answer the quizzes at the end of each chapter. During this time, I facilitated their access of the CD, ensuring that they followed the procedure correctly, particularly as the CD contained information for all the grades, and these Grade 10 learners needed to access only the information relevant to the Grade 10 curriculum.

Learners also used tutorials that I downloaded from Internet. These tutorials are simulations of the generation of electricity in a power station, distribution of electricity, three phases of the power plant and the interactive periodic table of chemical elements. Figure 3.2 below represents simulation of the generation of electricity using a boiler and figure 3.3 represents the distribution of electricity.

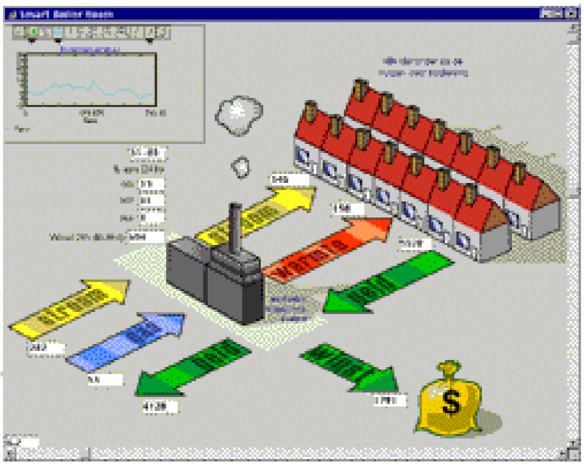

Figure 3-2: Zowel, (2001) Generation of electricity using a boiler

In figure 3.2 Learners learned how to generate electricity using a boiler. The learners clicked the arrows to generate electricity. They also learned how to convert gas and electricity into heat energy**.** Under electricity they further expanded their knowledge of electricity about how single and three-phase power differs (See Appendix D).

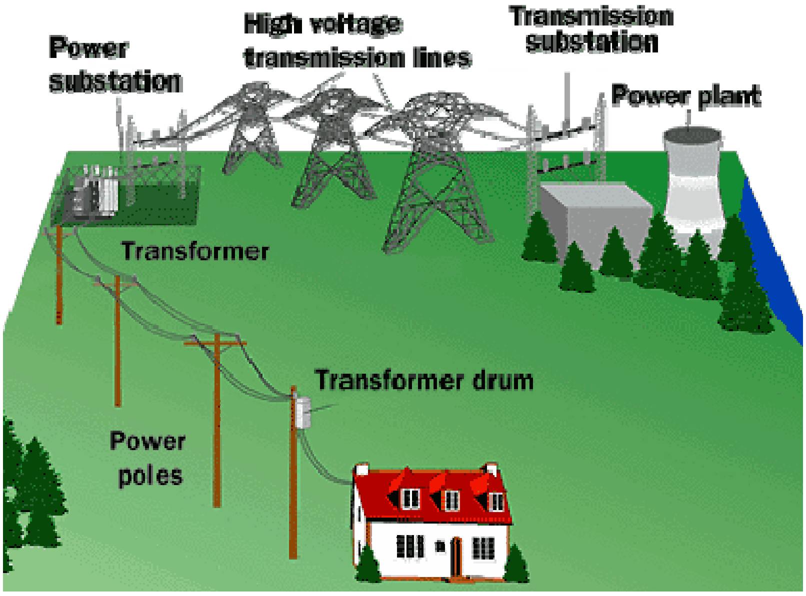

Figure 3-3: (Marshall, 2006) Power distribution grids

In the distribution of electricity, the learners learned how electricity moves from the power station to the transmission lines, power substation, transformer, and transformer drum, and to the house. Although this is not interactive, learners learned that after the electricity has been generated, it moves through different stages before it reaches the house. What is important about this particular activity is that it was the first time that these rural learners had access to a visual representation, which then brought the concept of power distribution to life.

	Metals	Actinium
	Semi-conductors	Select element
	Non-metals	Select element
	Inert gasses	Select element
	Lanthanides en actinides	Select element

	I	II											III	IV	V	VI	VII	VIII
1	H$_1$		Choose elements by name, by atomic number, by symbol, by mass															He$_2$
2	Li$_3$	Be$_4$											B$_5$	C$_6$	N$_7$	O$_8$	F$_9$	Ne$_{10}$
3	Na$_{11}$	Mg$_{12}$											Al$_{13}$	Si$_{14}$	P$_{15}$	S$_{16}$	Cl$_{17}$	Ar$_{18}$
4	K$_{19}$	Ca$_{20}$	Sc$_{21}$	Ti$_{22}$	V$_{23}$	Cr$_{24}$	Mn$_{25}$	Fe$_{26}$	Co$_{27}$	Ni$_{28}$	Cu$_{29}$	Zn$_{30}$	Ga$_{31}$	Ge$_{32}$	As$_{33}$	Se$_{34}$	Br$_{35}$	Kr$_{36}$
5	Rb$_{37}$	Sr$_{38}$	Y$_{39}$	Zr$_{40}$	Nb$_{41}$	Mo$_{42}$	Tc$_{43}$	Ru$_{44}$	Rh$_{45}$	Pd$_{46}$	Ag$_{47}$	Cd$_{48}$	In$_{49}$	Sn$_{50}$	Sb$_{51}$	Te$_{52}$	I$_{53}$	Xe$_{54}$
6	Cs$_{55}$	Ba$_{56}$	La$_{57}$	Hf$_{72}$	Ta$_{73}$	W$_{74}$	Re$_{75}$	Os$_{76}$	Ir$_{77}$	Pt$_{78}$	Au$_{79}$	Hg$_{80}$	Tl$_{81}$	Pb$_{82}$	Bi$_{83}$	Po$_{84}$	At$_{85}$	Rn$_{86}$
7	Fr$_{87}$	Ra$_{88}$	Ac$_{89}$	Rf 104	Db 105	Sg 106	Bh 107	Hs 108	Mt 109	Ds 110	Rg 111	Uub 112	Uut 113	Uuq 114	UUp 115	Uuh 116	Uus 117	Uuo 118

Ce$_{58}$	Pr$_{59}$	Nd$_{60}$	Pm$_{61}$	Sm$_{62}$	Eu$_{63}$	Gd$_{64}$	Tb$_{65}$	Dy$_{66}$	Ho$_{67}$	Er$_{68}$	Tm$_{69}$	Yb$_{70}$	Lu$_{71}$
Th$_{90}$	Pa$_{91}$	U$_{92}$	Np$_{93}$	Pu$_{94}$	Am$_{95}$	Cm$_{96}$	Bk$_{97}$	Cf$_{98}$	Es$_{99}$	Fm$_{100}$	Md$_{101}$	No$_{102}$	Lr$_{103}$

Table 3-1: Interactive Periodic Table (Lenntech, 1998)

In the interactive periodic table illustrated above, the learner clicked on an element to see the chemical properties, health effects and environmental effects of that element (I have deleted some of the content from the original table so that it can fit onto this page). The use of this interactive periodic table makes learning more meaningful as they by doing and seeing because the school has no laboratory to do experiments on chemistry, When working with the topic on force, learners learnt to define force and identify different kinds of forces. This section was also not interactive but learners learned how to represent force with vectors, by watching an animation of the force of gravity. They also learned how to calculate force in this way.

The topic on energy, heat and temperature taught the learners how to differentiate between heat and temperature, understand transfer of heat, as well as how to calculate heat lost or gained using the correct formulae. They also learned about heat transmission through radiation, conduction, convention and the three phase changes of water.

At the end of each topic, the learners completed ‘quizzes’ and these included force and force diagrams, weight, mass, normal force, frictional force, phase changes, added heat and thermal equilibrium. As the learners completed each quiz, their responses were computed and they were given immediate feedback. If the learners were not satisfied with their progress, they were able to redo the quiz.

The above topics are not the only those that the learners worked through using computers over a two week period, but they also serve as examples of what the learners were engaged with for that period. Examples of topics included in the tutorials are in Appendix E. The topics include force, energy, heat, temperature, and electricity. Again in Appendix E I included some of the quizzes, which the participants attempted to answer during the tutorial sessions.

3.8 DATA COLLECTION INSTRUMENTS

I selected particular methods of data collection because of their potential to provide the richest data as well as to emphasize cross-verification of the data sources. To achieve this objective, this study employed strategies and procedures associated with the qualitative approach, and included observation and interview (Marshall & Rossman, 1999).

3.8.1 Observation

Observation is a way to observe the everyday world. Some observations maybe unconscious and unsystematic (Merriam, 1998, p94) but using observation as a research tool allows the researcher to gain firsthand knowledge of a phenomenon of interest (Merriam, 1998, p94). Kidder (1981b, p264 in Merriam, 1998, p94) explains that observation serves a particular purpose as a research tool but should be deliberately planned and systematically recorded and should be subjected to checks and controls to ensure validity and reliability.

The first phase was to observe learners while they used the Physical Science software during Physical Science tutorials, some were from a particular CD ROM and others were downloaded from the Internet. The goal of using this software was to help the learners discover Physical Science for themselves and to try and build their confidence and interest in the learning area as well. The interactive nature of the software suited this purpose perfectly. Creswell (2003, p189) and Henning et al. (2004, p87) suggest two approaches of gathering observational notes. The approaches are gathering information as a participant and as an observer. I thus began as an observer, by collecting and recording information about the physical setting of the computer laboratory and a description of the 35 participants in the Physical Science class. In addition, the actions of the learners, which included the conversations, the language, as well as more subtle cues such as facial expressions, gestures, tone of voice and other unverbalized social interactions, which suggest tacit meanings (Merriam, 1998, p97), were also recorded.

Observations were conducted for two weeks during the time the learners were using the Physical Science software However, within the first two days of the study, my observational role in the computer laboratory changed, as I increasingly found situations arising that compelled my assistance and so my role changed to participant observer, which Henning et al. (2004, p42) explain is joining the setting as a stranger, but participating to a certain extent in the activities but later this role slowly evolved into one of an “instructor." As such, my responsibilities expanded to include assisting learners with using the computers to access the software. This included navigating the menus because many learners struggled with this skill even though I had spent the first 30 minutes of the first day demonstrating to them how the software works. As a researcher, I understood their situation because it was their first attempt to use CD and downloaded software, which was installed in their computers, and in addition, the software contained information not relevant to Grade 10 and therefore the learners were required to ignore this information, which also needed my attention. This participatory instructive role also helped to establish a comfortable rapport and level of trust between the learners and the researcher, which in turn facilitated data gathering.

During the third and following days, my role was primarily observational. My observations as suggested by Henning, et al. (2004, p88) was used to focus on particular activities such as communication between the learners and their excitement as they attempted to answer the questions that were included in the tutorials to stimulate them and to test their understanding as well as feedback on their responses.

Creswell (2003) suggests that the researcher should use observational protocol for recording observational data. To record my observations I followed his advice by using a single page with a dividing line down the middle to separate my observations and the descriptive notes and memos that I wrote to myself. These observations when used in conjunction with the interview data resulted in rich thick description (Merriam, 1998, p151) of the study.

3.8.2 Focus group interview

As Maxwell (1996) indicates, the interview is useful for gaining a description of actions and events which took place in the past or to which the researcher has had observational access. Therefore, for the second phase of data collection, I decided to conduct discursively oriented interviews in a focus group (Baker as cited in Henning, et al. 2004, p56), which would allow the respondents to interact with the interviewer in a social way (Holstein & Gubrium 2003). A focus group interview is a “carefully planned discussion designed to obtain perceptions in a defined area of interest in a permissive, non-threatening environment” (Krueger, 1988, p18) and its use is valuable in asking the participants very specific questions about a topic after extensive research has been done (Rubin & Rubin, 1995; Morgan, 1997). Merriam (1998) indicates that a focus group interview results in a rich and holistic description of a phenomenon offering insight.

Creswell (1998, p123) mentions that the researcher should determine the place to conduct interviews. I used the computer laboratory as a place to conduct the interview to make sure that no disturbance occurred. To understand how rural learners experience Physical Science presented using Information and Communication Technology (ICT) and to find out how this relates to their confidence in the subject, a focus group interview was conducted with 7 purposively selected Grade 10 Physical Science learners who had experienced the use of ICT as a tool for learning Physical Science. I was interested in finding out how engagement in the Physical Science lessons using computers shaped the learner's confidence in the learning area as well as collecting data on whether the use of ICT could spark curiosity and motivation with learners continuing to use ICT as a tool for learning Physical Science as well as other learning areas.

I used an interview protocol, which includes a heading, an instruction to the participants and the key research questions (Creswell, 2003, p190) and taking into account the interview guide suggested by McMillan and Schumacher (1989). According to this approach, the researcher asks questions concerning predetermined topics, but has freedom to choose the sequence and wording of the questions as the interview progresses. Questions were asked in an open-ended manner that allowed the learners a great degree of latitude to pursue a range of ideas and to shape the content of the interview (Bogdan & Biklen, 1992). Probing and clarification questions were also used to uncover specific meanings (Patton, 1990). However, during the focus group interview, I allowed the conversation to flow in whatever direction was helpful to providing insight and to explore and generate themes about how learners experience Physical Science presented using ICT. This also helped reveal ways in ICT relates to their confidence in the subject which they perceived the use of ICT in the teaching of Physical Science. The interview questions are:

1. Please tell me how you currently feel about Physical Science.
2. Have you always felt this way?
3. What made you feel this way?
4. What other issues can you mention about Physical Science?
5. Please tell how you experience the use of computers in the teaching of Physical Science.
6. What other issues can you mention about computers in the teaching of Physical Science?

As a researcher, I made sure that the physical environment was optimally geared, as indicated in Henning et al. (2004, p74) by having two tape recorders and a notebook available for record keeping purposes of interviewer's comments and reflective notes. The interview was later transcribed verbatim and analysed. (See Appendix A).

3.9 DATA ANALYSIS

After completing the data collection stage, and when qualitative data from field sources such as interviews were rendered into textual form by transcription, as suggested by Lee and Fielding (2004, p533), I found that I had accumulated large volumes of data. I organized the data from both observations and the focus group interview into what Yin (2003) calls a case study database. I organized my case study database in a chronological order so that I could move through the data from the beginning to the end of the process. This allowed me to perceive the progression of the process throughout and to make sense of the data (Merriam, 1998, p178).

Data was analysed by using simple content analysis (Strauss & Corbin, 1990 and 1998). In this process, data was coded into small units of meaning, which could be "as small as a word a participant uses to describe a feeling" (Merriam, 1998, p179) and should reveal information relevant to the research. These coded units of meaning were then categorised “to reflect the purpose of the research” in an attempt “to answer the research question” (Merriam, 1998, p183)

3.10 METHODOLOGICAL NORMS

Multiple sources of data collection, such as observation and a focus group interview, were used in this research to ensure reliability and validity.

3.10.1 Reliability

Reliability refers to whether the research, if conducted in a similar context will achieve similar results (Merriam, 1998:205). Reliability is conceptualized in terms of how reliable, accurate and precise the research tools or instruments are, determined empirically through several types of procedures and “whether the results are consistent with the data collected” (Merriam, 1998, p206).

To achieve reliability in this study, research questions and interview questions were pre-reviewed, to check for unclear and ambiguous questions. In order to be as non-threatening as possible to participants, and to ensure reliability of the data, the participants were informed beforehand about the mission of the researcher in their school. Participants were encouraged to air their views about the visit of the researcher to their school. Furthermore, the participants were free to use any language of their preference. Some of the questions were asked in Xitsonga to ensure that they understood them. In order to clearly express their feelings well, some of the learners responded in Xitsonga.

Reliability in qualitative observation revolves around detailing the relevant context of observation. This was acquired by following Spradley’s (1980, p73) suggestion that observers should keep short notes made at the time, and then expand notes made as soon as possible after each field session, record problems and ideas that arises during each stage of field of work a field of work journal and a provisional running record of analysis and interpretations. Although note taking gives the impression that I was an inspector or I was evaluating the learners, note taking is important so that I could remember everything that happened during the observation.

3.10.2 Validity

Stake (cited in, Tellis, 1997) indicates that validity could be assured in an inquiry such as this by triangulation of data and triangulation of method and in addition, “validity in research depends on good craftsmanship, investigation, continual checking, questioning and theoretical interpretation of the findings”. (Kvale, cited in Henning et al, 2004). Maxwell (1996) indicates that validity of an instrument is the extent to which the instrument measures what it is suppose to measure. However, qualitative research generates data that do not take the form of clearly standardized set of measurements.

To ensure validity, I employed triangulation (Creswell, 1994), which is integral to case study design. Triangulation is defined as "using multiple investigators, multiple sources of data, or multiple methods to confirm the emerging findings" (Merriam, 1998: 204). I employed methodological triangulation since I collected two forms of data: observations and interviews. Additional strategies to ensure validity are the use of member checks and long-term observations (Merriam, 1998, p205). I observed 35 participants while they learned through computers for the period of two weeks. I also conducted interview with 7 of the 35 participants.

3.11 ETHICAL CONSIDERATIONS

All 35 Grade 10 Physical Science learners participated in this research. All the learners are black, 21 boys and 14 girls with their age ranging between 14 and 16. However, the 7 learners who participated in interview were randomly selected.

The permission to conduct the research was requested from the circuit manager and the school manager in the form of writing. (See Appendix B for the letters from the circuit manager and school manager). Permission for the Grade 10 learners to participate in the research was obtained from both participants and parents/guardians. A consent letter signed by both participants and parents/guardians is attached (see Appendix C).

The participants learned various topics from the Physical Science curriculum presented using Information and Communication Technology (ICT) for a period of two weeks. They performed all the activities that were included in the tutorials, I observation them during this period and then I interviewed 7 of the participants.

At the start of the research process, I explained to the participants face to face on how the research will be conducted. Some of the information discussed was that learners would not be put at risk or endure bodily harm because of participating in the research. Furthermore, I discussed with them that all interviews will tape recorded and that they can withdraw from the research at any time without any penalty.

All information gathered from the participants is regarded as confidential and anonymous at all the times and is stored in a safe place. All participants from the interview are named as participants 1 to 7.

Participants have been ensured that they were free to respond to the interviews in their mother tongue or any language in which they felt comfortable. The interview was conducted in both English and Xitsonga. Some of the participants responded in English while others responded in Xitsonga as it is the mother tongue of the learners in the school.

3.12 SUMMARY OF THE CHAPTER

This chapter provided an overview of the qualitative approach and the research design that was used to conduct this study. I detailed a rationale for choosing this method, then described data collection, analysis, and procedures in relation to validity. The next chapter will present the data reporting and analysis that address the sub-questions of the study of this study.

CHAPTER 4:

INTERPRETATION OF DATA AND PRESENTATION OF FINDINGS

4.1 INTRODUCTION

The aim of this chapter is to report on how learners experience the use of ICT in the teaching of Physical Science and show how this possibly relates to their confidence in this learning area. Findings are based on research conducted at a single high school in Bushbuckridge, in Mpumalanga with Grade 10 Physical Science learners. Lee and Fielding (2004, p533) suggest data gathered from the field in the form of interviews and observation should be transcribed into textual form. Following Lee and Fielding's suggestion, I transcribed data from interviews and personal observations into text (see Appendix B & C). In order to preserve the essence of the participants' wording, interviews were transcribed verbatim. After the analysis of the transcribed observation and focus group interviews, data were saturated as evidenced in repeating themes. Data were analysed following Strauss and Corbin's (1990) method of simple content analysis.

4.2 CATEGORIES DERIVED FROM DATA ANALYSIS

I first read the transcribed data and generated codes. Data were first divided into small units of meaning and then coded according to the significance of the unit as suggested by Henning et al. (2004). Assigning comments using the track changes tool in Microsoft Word, I generated codes. The codes, with their references to specific lines, were then printed out onto paper and cut out into separate pieces. I then looked for codes with common elements within the data that had "issue-relevant meaning" (Creswell, 1998, p154) or significance for the study. Related codes were then grouped together into categories by clustering them into groups. I pasted similar codes within each group on separate sheets of A4 paper. The 4 main categories that emerged from this simple analysis are: Learners' concerns about the learning area, learners' experiences with ICT; learning through engagement through ICT and newfound expressions of confidence. Although four categories emerged from the data, some codes are relevant to more than one category and this is reflected in the following discussion.

4.2.1 Learners' concerns about the learning area

As a researcher I had a preconceived idea that all learners studying Physical Science should have confidence and display a positive interest in this learning area. However, learners raised various concerns about Physical Science prior to exposure to ICT.

All participants mentioned that they had displayed anxiety and fear of Physical Science before my intervention. The anxiety displayed was perhaps caused by the fear of performing Physical Science experiments, the lack of laboratory facilities and equipment, lack of qualified educators and the inherent fear of failing Physical Science. Evidence of this can be found in the following quotes: **"Lack of laboratory disadvantages us. I could not perform experiments"**. Lack of resources has a negative impact on the learners' understanding of scientific concepts and activities and participants recognized this issue after being exposed to my intervention. The following quote illustrates their frustrations in this regard: "**I am becoming more intimidated with Physics because we don't have CD's to use in the computer like this ones we have been using even if we have computers at school…"** The school in this study, situated in a rural environment in the Mpumalanga Province, has always been poorly resourced and even with the transformation in education, educators find that the textbooks are outdated, new textbooks incorporating the new curriculum are not being issued, charts and posters are in short supply and in addition the school has no laboratory or science equipment. ICT has the ability to address the lack of resources by making information, interactive tutorials and simulations available to learners studying Physical Science to support them in their learning.

Many of the participants indicated that the use of simulations as an alternative for experimentation relieved their anxiety and fear: **“Now that there is an alternative of video and simulation I feel that I am covered to continue studying Physical Science”**. From the evidence it is noticeable that learners value ICT for alleviating their anxiety and fear of Physical Science. They now feel good about Physical Science and they have overcome the misconceptions that are assigned to this learning area. However, as a researcher I realise that a significant removal of the anxiety and fear of the learning area would only be possible if learners were exposed to learning with ICT for a longer period and if it became part of the teaching and learning process.

The participant’s responses indicate that prior to their exposure to the ICT software they believed that Physical Science was difficult. Some participants seem to be more confident. This is indicated by the comments made by some of the participants who responded by saying that **“many people think Physical Science is difficult”** (See also line 40-42) and because of this perception, learners hesitate to choose Physical Science as a learning area to be studied through to Grade 12. Even though learners may wish to follow careers, which necessitate an understanding and background of Physical Science, they are still being influenced by this misconception. The use of ICT, however, has made learners realise that Physical Science is not difficult, as they perceived it. After completing the 2-week programme, where certain topics relevant to the Grade 10 Physical Science curriculum were completed, the learners indicated that using ICT to learn Physical Science topics had stimulated their interest, and motivated them. The computer played a role in clearing up this misconceptions that Physical Science is difficult**: “At first I thought it is difficult but as I started to learn it through the computer I think it is not difficult.”**

Lack of qualified Physical Science educators is a concern in South African education because it impacts on the learners’ participation in the learning area.

The issue of the lack of qualified Physical Science educators has also been mentioned in my literature review (See paragraph 2.4.3). The participants verify these concerns **"We also have no qualified teachers to teach Physical Science.** Some learners go so far as to identify the educators as the problem. This is illustrated by the following quote: ""**I think we need teachers qualified to teach the subject and motivate us as well as laboratory**." And other learners said: **I personally think if we can get disciplined teachers and disciplined students who are determined to deliver students from the lower grade will be influenced by us and like what we have delivered."**

Even though most participants reported that ICT motivated them, they have varied opinions of how ICT motivated them. To some participants, ICT motivated them to feel comfortable with Physical Science and hold Physical Science in high regard. This is indicated in the following quote: "**I just feel that I have a lot of confidence now that I learned through the computers. Before I saw the computer programmes I did not have confidence but now that I learned through computers it has boosted my confidence."** Other participants felt that ICT motivated them to study Physical Science further: **"I nearly stopped studying it but I had no chance of dropping it".** They are now motivated to study Physical Science related careers. "**Physics is a hardest subject because I am doing it for the first time. Most of the things that we learn in Physics will help us in our lives"** and **"I can now study a Science related career"** (See also line 145-146).

The participants indicated that initially they were uncertain about the use of ICT in the classroom because their computer skills were limited. Their only knowledge of the computer was through the word processor. This is evidenced by the following quote: "**I only knew that computers were used for typing and storing of information."** Despite this, the participants acknowledge the role of ICT in the learning of Physical Science. All respondents agreed that after the 2-week programme, their confidence in Physical Science has increased because all reported that they feel **"good"** when they learn Physical Science using computers. Other participants see ICT as a means to access knowledge, which was previously denied them, as the school seemed to be poorly resourced. The quote below shows that learners acknowledge the role of ICT as a source of information and knowledge. "**Computers have more information and more Physical Science terminology and it guided me to many things, which I did not know before."** It should be acknowledged that previously the dissemination of knowledge was through the printed media but in today's technological world, knowledge and information can be electronically accessed.

Furthermore, participants appreciated the new skills they gained when they used ICT to access information and complete activities such as responding to simulations using the ICT software. One learner explained: "**I felt like I was really performing the experiment**" and this was of particular importance as this school was poorly resourced in that it had neither a science laboratory nor equipment for conducting experiments. The use of software programmes, such as those used in the 2-week programme, can play an important role in allowing learners the opportunity to conduct experiments vital to the successful completion of the practical aspect of the Physical Science curriculum. In addition, the participants acknowledged that the software is focused on the Physical Science syllabus, "**unlike the teacher who teaches the whole year only to find that none of what he taught is asked in the exam. The computer only taught us what it will ask."**

Participants also highlighted the importance of assessment during the learning process. At the end of every section, the learners completed quizzes, which gave them immediate feedback. This is shown by the comments made by participants as they reported that **"At the end we were given some feedback, which is good"** and then they were motivated to proceed to the next section. This illustrates that immediate feedback is important as it assist learners to see their progress, which in turn, motivates them. Because the feedback was positive, it helped develop the learners' confidence in Physical Science. Furthermore, assessment is a way of finding out if the goals of the topics have been achieved.

4.2.2 Learners experiences of ICT

The participants acknowledge the role of ICT in the learning of Physical Science. All respondents agreed that after the 2-week programme, their confidence in Physical Science has increased because all reported that they feel **"good"** when they learn Physical Science using computers. Comments from the respondents indicate that their experience varied with all respondents reporting that they felt **"good"** using computers, as they were able to see that the difficulties of learning Physical Science can be overcome with support, in particular from ICT. Other participants see ICT as a means to access knowledge which was previously denied them as the school seemed to be poorly resourced. The quote below shows that learners acknowledge the role of ICT as a source of information and knowledge. "**Computers have more information and more Physical Science terminology and it guided me to many things, which I did not know before."** It should be acknowledged that previously the dissemination of knowledge was through the printed media but in today's technological world, knowledge and information can be electronically accessed.

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To some learners ICT is experienced as a means of learning at their own time and own pace. "**Learning Physics through a computer is valuable I have enough time to learn even during the afternoon or at night if I have a computer than with the teacher who only teaches for 30 minutes." Learning that takes place at own time and own pace is more to be remembered and applicable in the learners' life.** In chapter two I made a pointing out that learning that the new curriculum that when learners learn at their own pace the are involved in the constructive way of learning which allows them to construct their own knowledge and they can as well be able to apply the acquired knowledge in another situation.

4.2.3 Learner's engagement with ICT

The constructivist way of learning is seen as the most successful way of learning which influences the learner's construction of new knowledge. In Chapter 2 I indicated that constructivism is characterised by being learner-centred and encourages learner construction of own knowledge. I further indicated that ICT could be used to make learners construct their own knowledge, which in turn promotes the implementation of OBE and the RNCS, which is being implemented in South Africa (See paragraph 2.5). The participants acknowledge that ICT has the ability to assist them to construct their own knowledge as they commented that when they learn with computers, they are able to construct their own knowledge because they interact with the computers "**Everyday when I learned through a computer I get new information."** ICT allows learners access to information, which can supplement the outdated textbooks and their limited resources. This school has no library, which makes ICT a valuable tool for accessing information, which is both vast and up to date.

ICT is also regarded as having the means to unintentionally absorb learners in their work. The participants said that **"learning through computers is unintentional we do not crack our heads too much".** They saw the interactive, activity-based learning as a form of play with the simulations particularly characterising this type of learning. "**This is like a computer game"** and **"You play while you learn".** The observation schedule (Appendix C) also shows that the learners, busy with simulations, appreciate being involved in activities and did not really notice that in actual fact that they were learning, learning a particularly difficult aspect of Physical Science.

Participants also acknowledge the necessity of practical work and in my literature review I indicated that Physical Science is a practical learning area which involves all the senses (See paragraph 2.5.2.1). When participating in real experiments learners utilize all senses, as they have to touch the apparatus, observe the process, and see the results as well as smell the chemicals used in that particular experiment. A participant commented that "**I enjoyed watching the video and it assisted us because we do not have a laboratory for practical lessons. I also enjoyed being involved in simulation."** This shows that the learners are aware that Physical Science, to make learning more meaningful, should involve practical work. Access to software programmes, such as the ones used in the 2-week programme allows learner's access to practical Physical Science.

Discovery learning is viewed as a process by which learners discover their own learning. Research is another way of implementing discovery learning. Discovery learning took place as the software gave relevant information and in addition, the visual aspect of simulations scaffolded their learning. The comments made by participants fully illustrate that they are aware that discovery learning is more valuable because they can apply the discovered information (both in word and picture form) in another situation. This is illustrated by the following quote **"I learned a lot through simulation. Now I can write a report on generation of electricity."** Visual representations have an impact on learning and this was illustrated during the time of observation when learners commented about the animation of force of gravity. I thought that the learners knew about how Sir Isaac Newton discovered the force and was interested to observe their AHA moment when they were watching the animation of the force of gravity, "**Look at Newton. He is sitting under the tree".**

The participants further appreciated that ICT totally absorbed them in the work and that they were kept busy for two weeks. This shows that they are time conscious. This is indicated when they comment the following. **"The past two weeks were engaging and they pass without us noticing them.**" Active learning is one of the most influential learning which makes learning more meaningful. In chapter two I mentioned the importance of active learning (See also paragraph 2.5.2.1).

4.2.4 Newfound expressions of confidence

Grade 10 learners in the school under investigation have shown a major dislike for, fear of, anxiety with and lack of confidence in learning Physical Science. They further hold the misconception that Physical Science is difficult and so are likely to avoid Physical Science. The results of the study also revealed that the participants manifested varied feelings towards Physical Science that included its discontinuation in their studies, lack of motivation for its further study, as little or no confidence to pass the learning area. It is therefore necessary to identify those learners who lack confidence in Physical Science, and attempt to remedy this aspect before they are trapped into one of the above mentioned scenarios.

Comments from the participants indicate that using ICT to learn various topics from the Grade 10 curriculum developed their confidence: **“now that I learned through computers it has boosted my confidence.”** The ICT programmes gave the learners the opportunity to access the relevant information and then the quizzes tested them, giving them immediate feedback. In addition, the simulations allowed the learners to ‘see’ and experience aspects which previously had to be learned through words in a book. One learner commented: **“I just feel that I have a lot of confidence now that I learned through the computers**”.

The interactive nature of the ICT software ensured that the lessons were learner-centered, giving them the opportunity to ‘do it for themselves’: **“I felt like I was performing the experiment”,** and this led to one learner commenting: **“I gained confidence in performing some activities”.** As stated above, the practical side of Physical Science cannot be addressed if the school is poorly resourced and does not have a computer laboratory with the relevant equipment. Simulation therefore proves to be useful substitute for the real thing.

The findings showed that learners developed enough confidence to contemplate further study**: “I enjoyed [using ICT] and I am motivated to study Physical Science further”** (See also line 58). In my literature review I indicated lack of confidence impacts on the learners’ participation in the learning area (Paragraph 2.4) and in some cases this lack of confidence causes learners to ‘drop’ the learning area (i.e. not continue it through to Grade 12). However, the confidence mentioned clearly indicates that some learners will take Physical Science further into their higher education, particularly concentrating on Physical Science related careers: “**I think know I can follow a science related career.”** In Chapter 2, I mentioned that lack of confidence in Physical Science has an influence on learners when choosing a career related to the learning area, but it seems that some learners were now quite excited about considering a science related career, which could be important as applicants with skills for science-related careers are considered as scarce.

Many respondents reported that previously they had not passed the learning area, and even those who had passed, tended to obtain marks that were not satisfactory. Using ICT seems to have facilitated their learning and instead of feeling unsure and anxious about their competence in the learning area, had built confidence and perhaps for the first time allowed some learners to say: **“I think that I can pass the learning area”** and not consider ‘dropping out’. It was very clear from the learner’s responses that they were no longer intimidated by exams and they felt that with further access to ICT-related learning they would develop understanding and confidence in all topics which would motivate them towards passing the learning area not only at the end of Grade 10 but also strive to achieve good marks in the final Grade 12 exam: “**I feel that I am going to pass the exam”.** The assessment items in the software were a major help in this regard: “**To me the questions that we have answered were a sort of trial. They prepared me for the final examination. I think I can pass the subject.”**

This newly-found confidence to pass the learning area with improved results throughout the rest of their high school grades allowed the learners to dream of getting good results in their Grade 12: **“I have confidence that I can also get better symbols in Grade 12 to improve the G’s and H’s which the Grade 12 usually get in our school.”** It seemed that the learners were well aware that the schools pass rate and the symbols obtained by Grade 12 learners during the past years were not that good and their responses showed that they were confident about their ability to pass the final examination and make the school proud of their success. This was highlighted when the learner mentioned that the questions in tutorials prepared them for the final examination: **“Most of the questions prepared us for the exams because we shall be writing an external examination at the end of the year. I don’t think that I will be surprised to meet some of the questions in the exams because most of them are usually asked in the exam.”**

This study was designed to discover how the Grade 10 Physical Science learners experience the learning area presented using ICT, and how this relates to the development of their confidence in the learning area. In the light of literature review and learners' response to interview questions coupled with observations the following findings revealed that all learners were more confident in the learning area, confident to study it further and confident to pass the learning area in the final examination as well as their Grade 12 examination after using ICT programmes to facilitate their learning, addressing some of their concerns. It appears that a new concern can be raised because of lack of resources, such as software to use in the computers. However, if the school or the educator is in a position to find further ICT programmes and have access to the Internet for information, and continue with their type of curriculum development, it will further enhance the learners' confidence in Physical Science.

The results of the study further suggest that the exposure of learners to ICT in the learning of Physical Science, made learners experience ICT to be the most interactive way of learning. Further, ICT made learners participate in their learning more actively and to be engaging and time saving.

This research also confirms the role of ICT in the teaching of Physical Science that was discussed in my literature study in Chapter two. From the findings, the constructivist learning perspective is realised when ICT is employed in the learning of Physical Science, because ICT has more information, which learners could access, and use to construct their own learning.

My initial assumptions were that learners are not aware of the use of computers as a learning tool and that all learners would be interested in learning Physical Science through computers. In contrast, the findings only confirm the first part of the assumption and disagree with its second part. All learners were not aware of the use of computers for learning and some did not believe that computers motivated them, as they saw computers to be the same as textbooks. Although some thought that computers were like textbooks, the same ones confirmed that the questions in tutorials motivated them because of their immediate feedback, unlike the class test, which the educator will only give them feedback after marking the test.

My experience with Grade 10 Physical Science learners and the use of computers in the teaching of Physical Science culminating in these two weeks has shown me that technology can significantly motivate learners. I have attempted to use software programmes that reinforce and supplement the topics that the Physical Science educator had been teaching for the past 6 months. The computers have allowed the learners to become more active participants in their learning. They have become more engaged and less passive, as well as becoming active participants, rather than simple observers. They work at their own pace and find the computer to be non-judgmental. This confirms my literature review in chapter 2 which indicated that traditional ways of teaching led to passive learning and promoted less confidence in many Physical Science learners.

I come to the conclusion that ICT will not replace the educator, nor will it improve the teaching ability of a weak educator. It can, however, allow an educator to present material in more interesting and effective ways, which in turn would build confidence in Physical Science learners. Computer software should not replace the laboratory experience, but it can often provide an opportunity to conduct a particular experiment that would not be possible in a more usual situation, due to lack of equipment, which is the case in the school used for this study. Computer simulations in my study allowed learners to conduct an experiment, collect simulated data and evaluate it. Furthermore, computers allowed them to explore more and memorize less, which further expanded the building of confidence.

4.3 SUMMARY OF THE CHAPTER

This chapter presented and analysed the data obtained from observations and interviews. Using the categories below, data were analysed and presented: Learners' concerns about the learning area, learners' experiences with ICT, learning through engagement through ICT, and Newfound expressions of confidence.

The concerns of learners exposed in this study are fear and anxiety about the subject, lack of confidence, as well as lack of motivation, lack of resources and lack of qualified Physical Science educators. These concerns were largely addressed by the use of ICT in the teaching of Physical Science with many participants indicating that the learning area no longer intimidated them. Findings also indicate that the majority of the participants were eager to learn Physical Science using ICT. They enjoyed the form of assessment used in the software, as well as the immediate feedback they received after completing the quizzes. Participants benefited from the interactive learning constructing their own learning through the use of ICT to learn Physical Science and this approach embraced constructivist principles.

The overall findings of this chapter answer the research question of how rural learners experience Physical Science presented using Information and Communication Technology (ICT), and show how this relates to their confidence in the subject. The next chapter will present the summary, conclusion, recommendations for further research, and limitations of this study.

CHAPTER 5:

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

In the previous chapter, data were analysed, interpreted and presented. In this chapter, an overview of the study is given, conclusions are drawn, recommendations for further research are offered and limitations of the inquiry are identified.

5.2 AN OVERVIEW OF THE STUDY

Chapter 1 introduced the study, which arose from a concern about the limited number of learners studying Physical Science in many high schools in the Bushbuckridge area of Mpumalanga. It also gave a detailed background and explained the context in which the study was undertaken and stated the research question. **How do rural learners experience Physical Science presented using Information and Communication Technology (ICT), and how does this relate to their confidence in the subject?** To develop a framework for the research question of how the Grade 10 Physical Science learners experience the learning area presented using ICT, a review of the literature was conducted in Chapter 2. After this initial literature review, I began to investigate learners' experiences of the use of ICT in the teaching of Physical Science. Chapter 3 outlined the research approach taken, the research design and the data collection tools, which were used to gather data.

Learners were then observed over a two-week period during their use of Encore software (available for purchase in many retail outlets) and during their use of tutorials downloaded from the Internet. These were used to highlight specific topics in the Grade 10 Physical Science curriculum. Learners were then interviewed to find out how they experienced learning using ICT. The findings were discussed in Chapter 4.

5.3 CONCLUSION

Physical Science is labelled as a difficult learning area hence it tends to have a limited number of learners who choose to study it throughout high school. Lack of confidence in many learners leads them to avoid choosing it and those who study it tend not to achieve good results in their Grade 12 final examination. Learners' confidence in Physical Science is an important factor in achievement in the learning area, and therefore, it is the factor that tends to explain the poor and sometimes embarrassing performance of the Physical Science high school learners, particularly in the final Grade 12 examinations.

The objectives of this study have been realised. From the combination of the literature review and interpretation of data, I conclude that the learners' experiences of Physical Science presented using ICT reveal that it is both valuable and useful in motivating their interest and developing their confidence in the learning area, although some concerns were raised. Some of the concerns raised by the learners relate to the lack of qualified Physical Science educators as well as resources such as laboratories, and science equipment. Other concerns highlighted by learners include fear of the learning area as well as anxiety caused by the misconception that Physical Science is difficult. However, after the specific topics from the learning area were presented using ICT, learners indicated that they felt "good" about Physical Science. They were motivated to enjoy and interact with various topics, but most importantly construct their own learning at a pace suitable to their learning needs. Overall, learners acknowledged that ICT has developed their confidence in studying Physical Science.

However, as a researcher I realize that the two-week period with the use of a limited scope of software could not claim to address all their concerns. An effort was made to expose the need for building confidence in learners and hopefully all educators will work towards that goal, which will improve the pass rate of the learners. The pass rate will then and as a result the number of learners choosing Physical Science will increase in classes and the learners will be more motivated and confident about the learning area.

Educators in the rural areas are faced with the challenge of integrating ICT in education in order to provide quality practical work that will build learners' confidence so that they can fit into the ever-changing technological world and become competent adults as well as productive citizens. However, I came to conclusion that educators in the school used for this study are not aware of the vital role that computers can play in teaching and learning. My observations revealed that the educators at the school only consider using computers with learners for computer literacy. The computer skills were an important part of the study as they facilitated the learners' use of the various software programmes to learn Physical Science.

Learners' experience with the various software programmes changed their perception of the use of ICT and learners are now aware of the use of computers for learning. Their experience with computers equipped them with confidence to study Physical Science further although they initially held the misconception that it as a difficult subject. Although some of the learners did not credit computers in building their confidence, they still think the interactive nature of computers managed to prepare them for the final examinations which led me to the conclusion that if learners were offered further opportunities of learning through computers they will have more of a chance of passing Grade 12 Science with good symbols.

Learners are aware of the practical nature of Physical Science and the experience of using ICT is seen as an alternative for the lack of a science laboratory. Simulations are used in place of practical work with experimentation being done with computer software. Having access to computer simulations develops confidence in the learners allowing them the opportunity to perform experiments. In addition, computers and their software are a huge source of information and good alternatives for the lack of textbooks. Conclusions drawn from the findings, show that learners are aware of and appreciate the interactive nature of ICT as a new way to engage with Physical Science, and as a result, construct their own learning. Immediate feedback that they received during the assessment also reinforced their learning. Although educators were not aware of ICT and the science-related software, I came to the conclusion that with ICT software supporting both educators and learners confidence to perform classroom activities will be developed.

5.4 RECOMMENDATIONS FOR FURTHER STUDY

This study was a first step in developing confidence in Grade 10 Physical Science learners. Recommendations for future research include:

- Conduct a study on how in service training of Physical Science educators is improving their competence in the teaching of the learning area.
- Conduct a study on how the department supply the Physical Science resources at schools in Mpumalanga Province.
- Conduct a follow up study on the number of learners studying Physical Science at the school.
- Conduct a follow up study on how the learners used for the study choose their careers after they passed Grade 12.
- Conduct the study using Grade 11 and 12 learners to compare and contrast their responses with those of Grade 10 learners.
- Conduct follow-up studies to examine the learners' confidence and progress in their learning of Physical Science using ICT.

5.5 LIMITATION OF THE STUDY

This study depends on observation and interview data to reflect the learners' confidence in Physical Science after using and experiencing ICT to learn certain topics from the Grade 10 Physical Science curriculum.

The study is limited to single school, which cannot be considered fully representative of learners in the area. Furthermore, the study was limited to learners of one school, and as such the findings of the research cannot be generalised to the other learners of other schools. In other words learners from one school cannot be taken as the representation of Bohlabela district in Bushbuckridge area of Mpumalanga Province.

The time frame used for learners to use ICT for learning Physical Science was also limited. Furthermore, the numbers of computers were limited to an extent that two learners had to share one computer. Some learners did not have the basic computer skills to use the tutorials for learning which led to my role changing from that one of an observer to that of an instructor for the first two days. This change of role could have influenced the results of my observation.

5.6 FINAL WORD

The integration of ICT in teaching and learning is generally gaining more credence in the education system and learners should be given the opportunity of having access to this new way of learning. With Physical Science classes having reduced numbers of learners, the use of ICT programmes for learning of Physical Science has significantly brought changes to learners' perceptions about the learning area and further helps develop confidence in those learners. Evidence shows that Grade 10 learners at the school in this study had varied concerns about Physical Science, with one being lack of resources. However, ICT, giving access to a variety of software packages, is seen as addressing some of the concerns and in addition, ICT is also seen as a means of taking into account different learning styles. The learners have access to vast information sources, animations, interactive tutorials and self-assessments, which interests and motivate the learners. This then helps develop confidence in the Physical Science learner leading to greater competence and ultimately success in the subject.

The integration of ICT in the learning area of Physical Science is thus seen as vital in equipping learners with the relevant knowledge and skills to apply the scientific concepts to solving problems in their everyday lives.

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APPENDIX A:

DATA TRANSCRIPTION

INTERVIEW DATA

Date: 20-08-2006
Grade: 10
Rural learners’ experience

Key question: How does rural learners experience Physical Science presented using Information and Communication Technology (ICT), and how does this relate to their confidence in the subject?

INTERVIEWER: Please tell me how you currently feel about Physical Science?

RESPONDENT 1: Ja Physical Science is so very good. I feel good about Physical Science but many people think Physical Science is difficult but I don’t think so. Just because it is our challenge to be able to study it and get high marks.

INTERVIEWER: Have you always felt this way?

RESPONDENT 1: No, at the first time I was afraid of it but when I started to learn with computers I felt happy about Physical Science and it is now simple.

RESPONDENT 2: Myself I just feel that I have a lot of confidence now that I learned through the computers. Before I saw the computer programs I did not have confidence but now that I learned through computers it has boosted my confidence.

RESPONDENT 3: I personally think if we can get disciplined teachers and disciplined students who are determined to deliver the best. We can achieve better and learners from are the lower grade will be influenced by us and like what we have delivered.

INTERVIEWER: Have you always felt this way?

RESPONDENT 3: At first it was so difficult but I have realized that there is nothing impossible in life if you are determined to achieve you will achieve. Learning through the computer gave me confidence. I think that I can pass the learning area.

RESPONDENT 4: Hi ku vona ka mina Physical Science ayi hluphi hambi loko hidyondza hi nga ri na computer. Mina a ndzi ri na matimba hambi hi nga si dyondza hi computer without a computer. Meaning according to me Physical Science is not difficult. I had confidence to pass Physical Science even before we learned through computers.

RESPONDENT 5: Okay I think Physical Science is a good subject that we must learn and it is not easy if you did not learn. Computer yi na swilo swa ku tala. Na kona hi dyondze marito ya ku tala ya Physical Science lawa ahi nga mativi na kona yi hi pfune eka swo tala. Meaning Computers have more information and more Physical Science terminology that we did not know before we use computers and it guided me to many things, which I did not know before.

INTERVIEWER: What made you feel that way?

RESPONDENT 5: Computers made me feel this way because it has more information and more Physical Science terminology. I gained a lot of experience in many things, which I did not know before.

RESPONDENT 6: Physics is a hardest subject because I am doing it for the first time. Most of the things that we learn in Physics will help us in our lives. As many people say it is a difficult subject. At first I thought it is difficult but as I started to learn it through the computer I think it is not difficult and I can study it further and it is not difficult.

RESPONDENT 7: To me Physical Science is not difficult it only needs dedication. I don’t have problem in learning it because it is a practical subject.

INTERVIEWER: Have you always felt this way?

RESPONDENT 7: Yes since I started to learn it.

INTERVIEWER: Please tell me about the use of computers in the teaching of Physical Science.

RESPONDENT 1: Ja, I think computers are good because I can study on my own than in class because we have short time in class. We also have no qualified teachers to teach Physical Science.

RESPONDENT 2: I personally think that computers have more information. The computers have shown us some videos and because we do not have laboratories at our school we have been experimenting on the screen.

RESPONDENT 3: I personally think that computers are much better than teachers because they have more information. During school periods we are limited to only one period a day but with computers we can learn anywhere and anytime. The questions in the computer are of the same pattern as the ones asked in the examinations. Teachers only teach us summaries but with computers we get all the information.

RESPONDENT 6: When I started to learn Physical Science I only did it to please my teacher because he chose me to do it. Since I started to learn through computers I think I will study it in Grade 11. I nearly stopped studying it but I had no chance of dropping it. Another thing is that I think after I have passed Grade 12. I can now study Physical Science related career.

RESPONDENT 3: As many people label it as a difficult subject I think we must prove them wrong by passing it with very high marks.

INTERVIEWER: What made you feel that way?

RESPONDENT 3: Learning through computers made me love Physical Science.

RESPONDENT 2: Computer is valuable and is very valuable. We don’t usually finish all the chapters and you find that one teacher is teaching from Grade 8 to Grade 12. He then concentrates much to the Grade 12. When we use a computer we can complete the chapters within short time.

RESPONDENT 1: According to me a computer is the best. It is not moody and again it teaches us mostly educators do not teach everything. They teach the simple part of the textbook. I would like to spend most of the Physical Science periods in the computer digging for some information.

INTERVIEWER: Hmm.

RESPONDENT 1: At school we don’t have enough textbooks and the ones that we have is one series, which is difficult for us to do research when we are given a research task.

RESPONDENT 3: Learning Physics through a computer is valuable I have enough time to learn even during the afternoon or at night if I have a computer than with the teacher who only teaches for 30 minutes. I feel that I am going to pass the exam and I have confidence that I can also get better symbols in Grade 12 to improve the G's and H's which the Grade 12 usually get in our school. I will impress myself as well as my educators.

RESPONDENT 2: Computers have more information and it can have information of more than 7 textbooks. There is no need for me to carry a load of textbooks because most of the information is in the computer. Everyday when I learned through a computer I get new information and a computer does not look at its own side it gives all the information unlike the teacher who only teaches what he understands.

RESPONDENT 4: I think we need teachers qualified to teach the subject and motivate us as well as laboratory. A computer is like a textbook because it does not explain some difficult words used in science. I only see a little input from computer and it is the questions. The questions make us active and the corrections are given immediately unlike the test given by the teacher.

INTERVIEWER: What other issues can you say about computers in the teaching of Physical Science?

RESPONDENT 2: I enjoyed watching the video and it assisted us because we do not have a laboratory for practical lessons. I also enjoyed being involved in simulation. Computers kept us busy. There is no time, which we sat and do nothing. The past two weeks were engaging and they pass without us noticing them. I gained confidence in performing some activities in the classroom. I felt like I was really performing the experiment. If we can often use videos and simulation to perform practical work I feel I can also perform the experiments in a science laboratory if we can get one.

RESPONDENT 3: Lack of laboratory disadvantages us. Now that there is an alternative of video and simulation I feel that I am covered to continue studying Physical Science. If we can often use videos and simulations I am confident I can perform any Physics task when we do CASS and I will also pass.

RESPONDENT 6: I nearly dropped Physical Science. I did not cope with the chemistry part of the Physical Science syllabus. I have never passed this part since the beginning of the year, but I think through the use of computer simulation, I can pass this subject.

RESPONDENT 1: Questions that we undergone through assisted us. At first the questions were difficult and we were just guessing. As we go through the questions we became acquainted to them. At the end we were given some feedback, which is good. Some of the questions prepared us for the exams.

RESPONDENT 2: When we learn through computers we are kept busy all the time. The past two weeks were engaging and they pass without us noting them.

RESPONDENT 6: I saw the questions. At first they seem difficult because it was the first time for me to answer the questions in the computer. Most of the questions prepared us for the exams because we shall be writing an external examination at the end of the year. I don't think that I will be surprised to meet some of the questions in the exams because most of them are usually asked in the exam.

RESPONDENT 5: To me the questions that we have answered were a sort of trial. They prepared me for the final examination. I also like the fact that if you make a mistake, the computer tells you unlike in a regular test you have to wait until the teacher marks it, but the computer can tell you right away. I think I can pass the subject.

RESPONDENT 2: The questions were difficult at first because we did not know what was needed from us. As we proceed with them we became aware that the computer asks us exactly what we learned from it in the different chapters unlike the teacher who teach the whole year only to find that none of what he taught is asked in the exam. The computer only taught us what it will ask.

RESPONDENT 1: Computers are best because they have more information than the textbooks than educators. I think know I can follow a science related career. They are good.

RESPONDENT 2: When it comes to career choice I am definitely going to study career in science.

INTERVIEWER: What made you feel that way?

RESPONDENT 2: Computers are good because they have much information. I have confidence in continuing to study it. To me, I have a plea from the Department of education to supply us in the rural areas with computers and educators qualified to teach Physical Science.

RESPONDENT 2 : Loko hi dyondza hi computer a swi ti kombi na leswaku hi le ku dyondzeni. Hi dyondza hi nga swi twi. Meaning learning through is unintentional we do not scratch our heads too much.

RESPONDENT 1: I feel like educators could be totally replaced by computers. Only one or 2 educators could assist us in using the computers. A computer is not moody. Sometimes educators come to school with moods. With computers you can learn anywhere and anytime.

RESPONDENT 5: To me learning through computers came as a shock because I had no idea that computers can be used to learn. I only knew that computers were used for typing and storing of information.

INTERVIEWER: Hmm

RESPONDENT 5: Another thing is the video that we have seen by the way mam you said is simulation. It is like I have been doing the experiment because I took part in the experiment and I think if we can have a laboratory we can do experiments with confidence.

RESPONDENT 7: I am becoming more intimidated with Physics because we don’t have CD’s to use in the computer like this ones we have been using even if we have computers at school and I also think it is possible to follow science related career even if you do not learn by computer.

RESPONDENT 3: Here at school we are doing CASS (continuous assessment). CASS involves many things such as investigation and research. Computers will assist us to do research for CASS.

INTERVIEWER: Hmm anything you can say more?

RESPONDENT 5: One day while we were learning to type I clicked in one program called Encyclopaedia reference library. It has got a lot of information for all the subjects and the information can assist us in our

CASS activities even if we don't have the CD's and the program has contains information of other subjects.

RESPONDENT 3: I enjoyed the simulation of electricity. I did not know how electricity was generated but now I have a lot of knowledge. I felt like I was generating the real electricity when I clicked.

RESPONDENT 2: I learned a lot through simulation of power station. Now I can write a report on generation of electricity.

RESPONDENT 2: When we learn through we learn unintentionally and we do not scratch our heads. I enjoyed and I am motivated to study Physical Science further.

RESPONDENT 5: I was impressed by the questions. If you make a mistake, the computer tells you unlike test we write in class you have to wait until the teacher marks it, but the computer can tell you the mistakes at the same time.

INTERVIEWER: Do you still have something to say? If not, thank you for participating in this research. You will be notified about the findings of the research.

APPENDIX B:

LETTER OF CONSENT
(SCHOOL AND CIRCUIT MANAGER)

LETTER TO CIRCUIT MANAGER

P. O. Box 972
Bushbuckridge
1280
06 June 2005

The Circuit Manager
Dwarsloop Circuit
Private Bag x9411
Bushbuckridge
1280

I am currently completing a Masters degree in Computer-based Education in the Department of Mathematics, Science, Technology and Computer Education (Faculty of Education) at the University of Johannesburg. I am currently engaged in research, with the aim of determining how exposure to information and communication technology (ICT) can affect learners' attitudes towards Physical Science. In order to achieve the main aim of the study as stated above it is necessary to state the following objectives:

i. What does the literature reveal about learners' confidence in Physical Science at high school level?
ii. What does the literature indicate about the use of Information and Communication Technology (ICT) in the teaching of Physical Science?
iii. How do selected Grade 10 learners at a rural school describe their confidence in Physical Science and their experiences of using ICT in Physical Science lessons?

Science is considered as a most crucial subject that contributes significantly to the economic growth of developing countries. It increases skills and knowledge that empower students to cope better in the modern technological society. As you may be aware, the number of learners doing Physical Science in many high schools in rural areas is declining yearly. This may be caused by the negative attitude learners have towards science. My research question arises: **How does rural learners experience Physical Science presented using Information and**

Communication Technology (ICT), and how does this relate to their confidence in the subject?

I would like to enlighten you of the procedure that will be followed in this inquiry. The study will be conducted with 35 Grade 10 Physical Science learners. The study will include qualitative research. I hereby ask permission to let learners complete the questionnaires during the afternoon for quantitative research. I also ask permission to use the computer lab for one session during the Physical Science double period. Information on how the study will be conducted will be explained face to face with the consent participants. The learners who consent to be interviewed (after school hours or during breaks with your permission) will be informed of my intention to have the interview tape-recorded for data analysis purposes. These tape-recorded interviews will be analysed and stored in a locked facility. The research participants will be informed that participation in the study is voluntary and that they can withdraw from the study at any time without having to provide reasons. Participants will not be put at risk or harmed due to their participation in the study. Being indirectly involved in this inquiry you will also be privy to the outcomes of the research as they emerge.

I hereby appeal that you consent to sign this document below, in order to signify that you understand the conditions stated above and that you are aware of this research. This letter needs to be signed and dated as it forms part of the requirements for ethical research as authorization by the Ethics Committee of the Faculty of Education.

Thanking you in anticipation

____
Supervisor

____
S. Qhibi (Masters student)

________________________ ______________
Circuit manager Date

LETTER TO SCHOOL

P. O. Box 972
Bushbuckridge
1280
06 June 2005

Tsakani High School (Not a real name)
P. Box 936
Bushbuckridge
1280

I am currently completing a Masters degree in Computer-based Education in the Department of Mathematics, Science, Technology and Computer Education (Faculty of Education) at the University of Johannesburg. I am currently engaged in research, with the aim of determining how exposure to information and communication technology (ICT) can affect learners' confidence in science. In order to achieve the main aim of the study as stated above it is necessary to state the following objectives:

What does the literature reveal about learners' confidence in Physical Science at high school level?
What does the literature indicate about the use of Information and Communication Technology (ICT) in the teaching of Physical Science?
How do selected Grade 10 learners at a rural school describe their confidence in Physical Science and their experiences of using ICT in Physical Science lessons?

Science is considered as a most crucial subject that contributes significantly to the economic growth of developing countries. It increases skills and knowledge that empower students to cope better in the modern technological society. As you may be aware, the number of learners doing science in many high schools in rural areas is declining yearly. This may be caused by the negative attitude learners have towards science. My research question arises: How does rural learners experience Physical Science presented using Information and Communication Technology (ICT), and how does this relate to their confidence in the subject?

I would like to enlighten you of the procedure that will be followed in this inquiry. The study will be conducted with 15 Grade 10 Physical Science learners. I hereby ask permission to use the computer lab for one session during the Physical Science double period. Information on how the study will be conducted will be explained face to face with the consenting participants. The learners who consent to be interviewed (after school hours or during breaks with your permission) will be informed of my intention to have the interview tape-recorded for data analysis purposes. These tape-recorded interviews will be analysed and be stored in a locked facility. The research participants will be informed that participation in the study is voluntary and that they can withdraw from the study at any time without

having to provide reasons. Participants will not be put at risk or harmed due to their participation in the study. Being indirectly involved this inquiry you will also be privy to the outcomes of the research as they emerge.
I hereby appeal that you consent to sign this document below, in order to signify that you understand the conditions stated above and that you are aware of this research. This letter needs to be signed and dated as it forms part of the requirements for ethical research as authorization by the Ethics Committee of the Faculty of Education.

Thanking you in anticipation

____

Supervisor

____

S. Qhibi (Masters' student)

__________________________ _______________

School Manager Date

APPENDIX C:

LETTER OF CONSENT (PARENTS)

P. O. Box 972
Bushbuckridge
1280
06 June 2005

Dear parent/guardian of ________________________________

I am currently studying in the Department of Mathematics, Science, Technology and Computer Education (Faculty of Education) at the University of Johannesburg. I am currently engaged in research, with the aim of determining the impact of information and communication technology (ICT) on learners' attitudes towards science. The number of learners doing Physical Science in many rural high schools is deteriorating every year. This matter also affects your child's high school. Some children seem to have a negative attitude towards Physical Science. I argue that this affects our children and that these pupils ultimately cannot cope with the demand of new technologies in later life due to a lack of exposure and positive attitude towards information and communication technology (ICT) at high school level.

I would like to invite your child, with your approval, to form part of this study by agreeing to be interviewed and having this interview tape-recorded for data analysis. This tape-recorded interview will be analysed and be stored in a locked facility. Please note that even if you do agree to be part of this study, your child's participation in the study is voluntarily and that he/she can withdraw from the study at anytime without providing reasons. All information gathered from the participants will be regarded as confidential and anonymous at all the times. In addition, it is my belief that there are a number of possible benefits for your child as participant in this study. Being part of this study they will be privy to the outcomes of the research as they emerge and will be given the opportunity to comment on their contribution and thus inform the study.

Hence, I hereby request that you sign the attached document, in order to show that you understand the conditions stated above and that you have accordingly given your child permission to take part in this study and to be interviewed by me. This letter must be signed and dated by the participant and parent/legal guardian as it forms part of the requirements for ethical research as mandated by the Ethics Committee of the Faculty of Education.
Thanking you in anticipation

____
S. Qhibi (Researcher)

APPENDIX D:

EXAMPLES FROM TUTORIALS

Screenshots from the tutorial

On the screen above, learners used the buttons on the left as a means to navigate the tutorial. The tunnel is linked to all the instructions on how to use the tutorial. The lessons button is linked to the different chapters in the tutorial; the quiz button is linked to the different quizzes for each chapter: and the story button links to a number of Physical Science scenarios to illustrate certain laws such as the law of gravity.

In the table of contents above learners used the menu as a means to navigate the tutorial. Pop up messages is used as “mouseovers” on the buttons.

From left to right: the first button with a pencil is linked to the quizzes; the second one is the help button; the third button is for printing of any page from the tutorial.

From top to bottom we find a search option and a bookmark button. The button below the bookmark is linked to the content of different chapters found in the tutorial. The button below the content button is linked to videos. The button at the bottom is clicked when moving to the next page. The menu on the left is linked to different topics that are found in the chapters. Mouseovers show the different topics in each chapter.

The screenshot above shows topics found in chapter 1. The screen below has quizzes of the different chapters. Learners clicked chapters to test themselves using the quizzes. Each quiz has four different responses which a learner could click and also get feedback by clicking the report button. This page has options to print, to quit the quizzes, to go back to the previous quiz or to go to the next quiz.

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The screen below shows the video demonstrating that the boiling point of water depends on the temperature of the air above it.