AN INVESTIGATION INTO THE USE OF MATHEMATICS SOFTWARE IN THE TEACHING AND LEARNING OF MATHEMATICS AT PHUTHADITJHABA HIGH SCHOOL: A CASE STUDY

by

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Submitted in partial fulfilment of the requirements for the degree of

MASTERS OF EDUCATION (ED. TECH)

in the Department of

EDUCATION STUDIES

at the

UNIVERSITY OF KWAZULU-NATAL

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January 2006

DECLARATION

I declare that "An investigation into the use of mathematics software in the teaching and learning of Mathematics at Phuthaditjhaba High School" is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I. Matabane

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to the following:

Mr S.B Khoza, my supervisor, for his invaluable advice and guidance throughout this study. With the assistance from Mr Khoza, it made this study a very pleasurable one to have undertaken.

To the school, educators and learners, thank you for participating in this project, your inputs have helped tremendously in the shaping this project.

DEDICATION

To all my colleagues that assisted me directly or indirectly in this study, thank you, your support has helped keep me focused on the goal of completion for this study.

To my mother, Paulinah Matabane and my brother Jacob, thank you for your assistance in seeing this project complete.

To my son, Atang, I appreciate your patience and understanding while I was busy with this project.

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CHAPTER ONE

OVERVIEW OF THE STUDY

Topic : An investigation into the use of mathematics software in the teaching and learning of Mathematics at Phuthaditjhaba High School.

1.1 Introduction

This chapter outlines the use of mathematics software in the teaching and learning of mathematics. The name of the school is Phuthaditjhaba High School, which is in the rural areas of KwaZulu Natal, Greytown area. Most of the learners at the school are orphans, and are coming from disadvantaged homes. The enrolment is too high and the classrooms are limited. In one class, there is a ratio of seventy learners is to one educator and there is no enough floor space for teaching and learning to take place effectively.

Phuthaditjhaba High School was fortunate that it was the first High School in Matimatolo area in Greytown to be supplied with computers. By then, an educator who was teaching computers was not a qualified one, although he had some knowledge about computers.

The school was supplied with ten computers. Immediately after that, another five computers came. Unfortunately these were not complete computers because they did not have the Central Processing Unit (CPU). A qualified educator was employed and she introduced Computer Literacy in Grade 9. What happened was that, only the educator and her Head Of Department (HOD) had access to the computers.

Because of some certain reasons, the HOD was redeployed so the educator became in charge of those computers and worked as a HOD.

In 2003, the school was supplied with sixteen computers and five of those computers,were set aside for enhancing the teaching and learning of mathematics, science and languages. The researcher is focusing on the mathematics software that was supplied. Grades 11 and 12 mostly use this software.

The outline or background presented explains what initiated this study. A brief methodology for this study is also outlined in this chapter. Finally, limitations of this study are discussed.

1.2 Statement of purpose

To investigate the use of mathematics software in the teaching and learning of mathematics at Phuthaditjhaba High School.

1.3 Critical Questions

This study focuses on the following critical questions in assisting the main research topic:

1. How and why do the educators and learners use mathematics software in teaching and learning mathematics at Phuthaditjhaba High School?
2. What value, significance and importance does mathematics software have in enhancing learning and teaching at Phuthaditjhaba High School?

1.4 Rationale

The reason why the researcher decided to conduct the study is because when the software came, it was said that all educators are free to use the software from Grade 8 to Grade 12. All of a sudden, only educators who are teaching Grades 11 and 12 are using that software, especially mathematics educators. Even if the educators are letting learners to use the software, in most cases learners are by themselves no one is assisting them.

The researcher also found out that most learners are eager to use computers but they are denied access to the computers. The researcher says this because the researcher is the educator for Technology. One day learners from Grade 9 asked the researcher when are they going to use the computers, especially the ones that are said to have some helpful software,for example for languages. That statement on its own made the researcher to see that the learners are willing to have the knowledge on how to use computers but there is no one who is prepared to do so. Only Grade 12, doing mathematics, can use the software. One day one learner said to the researcher: 'I wish I was doing Grade 12.' The researcher asked why and the learner said: "So that I can be allowed to use the computers.' That learner was trying to pass on the message to the educator.

The researcher feels that every learner must be given a chance to this software as it said that they are there to help learners. The software is of importance to both learners and educators what the researcher wants to know is that, Is it how the software must be used or are there any gaps in using it.

1.5 The overview of the research methodology

1.5.1 Approach

This study uses qualitative method of data collection and analysis. Qualitative data sources include observation and participant observation, interviews and questionnaires, and the researcher's impressions and reactions. "Qualitative research methods are designed to help researchers understand people and the social and cultural contexts within which they live" (Myers , 1997).

Qualitative research can be positivist, interpretive or critical. The researcher is using the case study method. A research method is a strategy of inquiry which moves from the underlying philosophical assumptions to research design and data collection. The choice of research method influences the way in which the researcher collects data. A case study research can also be positivist, interpretive or critical, just as action research can be positivist, interpretive or critical. This case study research is an interpretive research. Interpretive researchers start out with the assumption that access to reality is only through social constructions such as language, consciousness and shared meanings.

In quantitative research, the goals are established early in the research process and remain fixed static for the duration of the research. In qualitative research, goals are likely to be more flexible and can be altered or redesigned as the research progresses, depending on circumstances such as the outcomes at different stages in the process of research. The researcher also takes into consideration the issue of validity and reliability.

"Validity is an agreement between two efforts to measure the same thing with different methods" (Campbell and Fisk, as cited by Hammersely, 1987).

Validity is not a singular acid test that can be applied to the research process as a whole. Winter (2000) argues that the "validity" measure can be applied differently depending upon the researcher's belief as to what stage of the research process is in need of validation. Within the qualitative paradigm, interpretation is viewed as an inextricable element of data collection. "Interpretation is essentially couched within the rhetoric that the researcher uses to describe a situation and is mutually constructed between researchers and subjects." (Winter, 2000).

Qualitative research has concerned itself with the meanings and personal experiences of individuals, groups and sub-cultures. Reality in qualitative research is concerned with the negotiation of truths through a series of subjective accounts. Whereas quantitative researchers attempt to disassociate themselves as much as possible from the research process. The researcher plays the role of neutral and objective observer or interpreter. The researcher is removed from the data. She is acting from an outsider's perspective.

Qualitative researchers have come to embrace their involvement and role within the research. Because of the evaluative nature of qualitative research, the researcher is a key instrument or tool in the research. "The researcher's insight, expertise and understanding is an important element in the research process." (Naidoo, 1996) The researcher is likely to be a participant observer in the research process. The researcher is close to the data. The researcher is acting as an insider perspective.

According to Winter (2000) for quantitative researchers, this involvement would reduce the validity of a test, yet for qualitative researchers, denying one's role within research also threatens the validity of the research.

1.5.2 Sampling

In order to select a sample from the population, a sampling frame is needed. Sampling frame is a clear, unambiguous description of the target population. This is needed so that the researcher knows who belongs to the population and who does not. "In qualitative research, the sample of individuals selected for a study is central to the entire research process"(Naidoo, 1996). In a sense, one is considered special or unique

The researcher is using cluster sampling in this study. As Phuthaditjhaba High School starts from Grade 8 to Grade 12, the researcher's study only focuses on Grade 12 learners, not the whole school. The researcher chose this Grade because they are the ones who are using the mathematics software for teaching and learning mathematics.

1.5.3 Research Instruments

The researcher uses more than one technique for collecting empirical data. These techniques range from interviews, observational techniques such as participant observation. For Critical Question number one, the researcher used participation observation for the how question. The researcher choose to use participation observation because it is the only way the researcher can see the way in which the participants use mathematics software in teaching and learning mathematics at Phuthaditjhaba High

School. It is easy for the researcher to get answers when she is part of the audience. "The researcher's insight, expertise and understanding is an important element in the research process" (Naidoo, 1996).

For the why question, the researcher used the semi-structured interviews with both learners and educators as a method for in-depth probing. The researcher conducted interviews during non-teaching periods or during lunch times. The interviews were informal and began with the researcher attempting to relax the participants and assuring of the confidentiality and of their anonymity. All interviews were recorded by means of a tape recorder with permission from the participants, and transcribed them. Where possible, participants got a chance to read over their transcript to make sure that the researcher has correctly recorded what the participants stated.

However, the researcher is aware of the limitations of interviews, such as getting socially desirable answers from participants and of the effect of the researchers presence and the way that the researcher phrased the questions that altered responses of the participants.

For the critical question number two, the researcher used questionnaires. There are things that limited the researcher in this methodology. Time constraints is one of the main difficulties that someone can face as you can find that your participants are not available when you are and vice versa. A school runs its own timetable and it is the researcher's duty to slot her in accordingly. Sometimes, the researcher was told that learners were writing tests or examinations. Interviews have their limitations because participants were not always honest in their responses and gave socially desirable responses. Also, the

researcher own manner as a researcher, the researcher's tone of voice or emphasis had an influence on participant's responses. An interviewer can seek out answers that support their preconceived notions surrounding the research area.

1.5.4 Data Analysis

The researcher used a range of descriptive and evaluative analysis including discourse analysis and comparative analysis. Data analysis was an ongoing process where the researcher searched for similarities, patterns and themes that emerged from the data the researcher collected. The taped interviews were transcribed and read many times in order to derive themes.

1.6 The overview of related literature

South African education is in a state of change. Sewell (2000) argues that the Department of Education is forcing the pace of change but, at the present time insufficient policy has been defined to enable one to judge the new system. Educators are the key to successful science education. They influence the development of pupil's knowledge of, and attitudes towards science as an enterprise. Accepting that this is so, does not mean that educators are required to be the source of all knowledge and it is important that educators do not feel threatened by the fact that their pupils may know more than they do in some areas.

A computer is made up of two main elements, namely hardware and software. Hardware refers to, for example, the screen, the keyboard, all the cables and components inside the computer. Hardware is therefore all the parts of a computer that you can see and touch. Software is the collective name for all types of computer programs. "A computer program is simply a large collection of instructions which tell the computer how to do a specific

job" (Jacobs, 2000) Examples of software include Windows, DOS, Word Perfect, Microsoft Word, Microsoft Excel, etc. Programs are invisible and we are unable to touch them. They are stored on disks as magnetic patterns. The disk that holds the program is hardware, the program itself is software.

A computer consists of the following, that is, input devices, output devices and the processing unit. Examples of the input devices are :the keyboard, mouse etc. The devices are essential for our communication with the computer. The output device we are familiar with is the monitor or screen. The screen is becoming increasingly important as it provides the all important interactive interface between the user and the computer. The processing unit is divided into the Central Processing Unit (CPU), Compact Disc, Read Only Memory (CD ROM) and the Random Access Memory. The CPU is the part of the computer that does all the work. It fetches instructions and data from the memory and carries out the processing that the instructions tell it to do. ROM is usually memory that contains programs only. Jacobs (2000) argues that the programs contained in ROM are usually small and do not need to be modified. An example of such a program is the BIOS (Basic Input Output System) which controls the basic input and output functions of a computer. RAM is the memory that holds the programs that we run on the computer and the data that these programs work with. This is the memory that has the greatest impact on how powerful our computer is and what type of programs we can write for it or run on it.

Software is a means of telling the computer what to do. There are categories of software: systems software, programming languages, operating systems, commercial utility packages, data communications software, application development software and

application software. According to Jacobs (2000) System software is software that is intended to control, support or operate the computer. It is a set of electronic instructions that tell a computer what to do. You cannot see or touch software but you can see and touch the packaging the software comes in. Examples of system software are operating systems such as Windows 98 and Linux.

An operating system is a group of programs that provides the interface between you (the user) and the hardware (your computer).It translates your commands to the computer so that you can perform such tasks as creating files, running programs and printing documents. Utilities area sub-category of systems software designed to augment the operating system by providing a way for a computer user to control the allocation and use of hardware resources. Some utilities are included with the operating system; they perform tasks such as preparing disks to hold data (formatting), providing information about the files on a disk and copying from one disk to another. Anti-virus software packages, such as Dr. Solomon's Anti-virus Toolkit, can also be purchased to protect your computer from viruses that could damage or erase your files.

Data communications software can be grouped into the same two categories used to class all software: applications software and systems software. Application software is directly used to satisfy the user's needs involving their work. Such software requires the use of the highest layer of protocols. Application layer software and protocols provide commonly needed communication utilities which work in supporting user applications. For example, they help to send files and email messages across the network. The most familiar include email packages such as Eudora and web browsers such as Netscape. (Jacobs, 2000)

Applications software refers to programs that the end user buys or develops in order to solve a specific problem or perform a particular task. It lets the user accomplish specific tasks. Popular application software includes word processors such as Microsoft Word, Lotus 1.2.3, etc.

The secondary memory of a computer refers to media such as disks and tapes on which programs and data can be saved. An advantage of having secondary memory on the computer is that it allows work to be saved before switching off the computer or exiting a program, and then loaded when we want to continue working. The hard drive is the most commonly used device for the storage of information on personal computers.

The researcher is looking at the applications software. The researcher talks a lot about the software in chapter two-Literature Review.

1.7 **The overview of the theoretical framework**

The theory used by the researcher on her study are constructivism on both her/his participants. According to Bencze (2000) learning is an active process in which learners construct new ideas or concepts based upon their current or past knowledge. The learner selects and transforms information, constructs hypotheses and makes decisions, relying on a cognitive structure to do so. Cognitive structure provides meaning and organization to experiences and allows the individual to go beyond the information given.

In a constructivist classroom, student's autonomy and initiative were accepted and encouraged. By respecting student's ideas and encouraging independent thinking, educators helped students attain their own intellectual identity. Learners who frame questions and issues and they went about analyzing and answering them, taking responsibility for their own learning and becoming problem solvers. The educators asked open-ended questions and allowed time for responses. Reflective thought took time and was often built on other's ideas and comments. The way educators asked questions and the way learners responded structured the success of student's inquiry(Bencze, 2000).

Higher-level thinking is encouraged. "The constructivist educators challenge learners to reach beyond the simple factual response"(Brooks and Martin, 1993). The researcher encouraged learners to connect and summarize concepts by analyzing, predicting, justifying and defining their ideas. Learners were encouraged in dialogue with the educator and with each other. Social discourse helped learners change or reinforce their ideas. If they had the chance to present what they think and hear other's ideas, learners built a personal knowledge base that they understand. Only when they feel comfortable enough to express their ideas will meaningful classroom dialogue occur.

Learners were engaged in experiences that challenged hypotheses and encouraged discussion. When allowed to make predictions, learners often generated varying hypotheses about natural phenomena. The constructivist educator provides ample opportunities for learners to test their hypotheses, especially through group discussion of concrete experiences(Brooks and Martin, 1993).

In constructivism, learning occurs because personal knowledge is constructed by an active, a self-regulated learner who resolves conflicts between ideas and reflects on theoretical explanations. Sources of meaning are experiences and context, there is a real world, which we experience. Meaning is imposed on the world by use, there are many meanings or perspectives for any given event. Goal of instruction is not to assure individuals know particular things but construct plausible interpretations of their own.

This theory is based on the premise that people construct their own perspective of the world, based on individual experiences and schema. It focuses on preparing the learner to problem solves in ambiguous situation. In this theory, the emphasis is placed on the learner rather than the educator. Something that the researcher did in this study, she focused on the learner rather than educators because it is the learner who interacts with objects and events and thereby gains an understanding of the features held by such objects and events and thereby gains an understanding of the features held by such objects. The learner therefore constructs his own conceptualization and solutions to problems. Learner's autonomy and initiative was accepted and encouraged.

Constructivists view learning as the result of mental construction. Learners can learn by fitting new information together with what they already know. People learn best when they actively construct their own understanding. In constructivist thinking, learning is also affected by the context and the beliefs and attitudes of the learner. Learners are encouraged to invent their own solutions and to try out ideas and hypothesis. They are given the opportunity to build on prior knowledge (Seels, 1996).

There are many different schools of thought within this theory, all of which fall within the same basic assumption about learning. The main two are social constructivism and cognitive constructivism. Social constructivism implies that constructivist theory stress collaborator efforts of groups of learners as sources of learning and the cognitive constructivists emphasize the exploration and discovery on the part of each learner as explaining the learning process. In this view, knowledge is still very much a symbolic mental representation in the mind of the individual. Constructivism emphasizes learning and not teaching, encourages and accepts learner autonomy and initiative, sees learners as creatures of will and purpose (Hein, 1991). It thinks of learning as a process.

1.8 Limitations

Some of the things that limited the researcher on her study are as follows:

- Some of the learners did not want to participate. The researcher thought that this was because the learners were not interested or their parents did not want them to be part.
- The personal nature of qualitative work does not always allow a researcher to remain truly neutral. Sometimes, the researcher was too familiar with participants, and this made it difficult to stand back and be truly crucial.
- The researcher had to arrange time in order to do the interviews but sometimes she failed because of the activities that happen within the school. Sometimes learners were writing exams so now the researcher could not interfere with that.
- Sometimes educators were absent from school to attend activities (South African

Democratic Teacher's Union activities, workshops) so now the researcher was disturbed in that way.

1.9 Conclusion

Bennet (1996) argues that full-computerized schooling in South Africa is not only possible because of the quality of the established infrastructure, but that it is absolutely essential in order to quickly correct the educational legacy of Apartheid, ensure development, cement gains in democracy and prevent inner city difficulties.

This chapter was just an overview of what the researcher is going to do in her research. The next chapter, the researcher will go into details on other researcher's views on the use of applications software in teaching and learning.

CHAPTER TWO

LITERATURE REVIEW, HISTORICAL PERSPECTIVES AND DEFINITIONAL ISSUES

2.1 Introduction

This chapter defines and outlines what software means by looking at who and what it should satisfy within the school environment. It also captures the importance of using mathematics software and its contribution to the school. Some years back, only those schools whom were referred to as "Model C Schools" had benefited from using such software. This chapter also reveals some of the imbalances in the South African education system.

2.2 Computers as one of the most important tools of Technology

A lot of research has been done about Computer Assisted Learning. The studies show that the use of technology in instruction tends to be by individual teachers. Few schools as a whole embrace technology and use it to transform the content and mode of instruction. Petronia (1996) argues that evidence that technology can enable instructional practices that yield significantly improved outcomes on schools are sparse. While parents strongly support the introduction of technology in schools, this support seems to reflect a belief that skill in the use of computers and telecommunications is key to success in the workplace rather than that such technology can lead to fundamentally improved schooling.

A computer can serve as a freestanding workstation that provides tutoring to a student and can be structured to adapt to his or her responses. It can serve as a word processor or to support desktop publishing for reporting the work of students. In Phuthaditjhaba High School, this is what they know about computers. The only use computers for this purpose. They are not aware that computers can do a lot other than this.

There have been many efforts through the years to introduce technology into classroom. Researchers show that in the 1960s and 1970s, a strong effort was made to introduce instructional television into classrooms. "The vision of individuals and organizations that promoted educational television failed to be achieved and there is little evidence that educational television made much of an impact upon the typical school"(Koltutsky, 2001).

Computers in some schools help teachers to keep themselves trained on the latest equipment and software. Something, which does not happen at Phuthaditjhaba High School. If you know nothing about computers, you stay as you are and only those who are computer literate are trained. Teachers must constantly adapt their curriculum to the changing needs of their students that computer technology can bring about. With the Internet, teachers are no longer necessarily the centers of instruction. The role of the teacher begins to change to that of a person who guides students towards finding and sorting through information. It is unrealistic to expect that teachers can teach all the necessary information that students will need to succeed in a community that expects tougher requirements than ever before.

2.3 Definition of software.

Software is a means of telling the computer what to do. There are categories of software: systems software, programming languages, operating systems, commercial utility packages, data communications software, application development software and application software. According to Jacobs (2000) System software is software that is intended to control, support or operate the computer. It is a set of electronic instructions that tell a computer what to do. You cannot see or touch software but you can see and touch the packaging the software comes in. Examples of system software are operating systems such as Windows 98 and Linux.

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highest layer of protocols. Application layer software and protocols provide commonly needed communication utilities which work in supporting user applications. For example, they help to send files and email messages across the network. The most familiar include email packages such as Eudora and web browsers such as Netscape.

Applications software refers to programs that the end user buys or develops in order to solve a specific problem or perform a particular task. It lets the user accomplish specific tasks. Popular application software includes word processors such as Microsoft Word, Lotus 1.2.3, etc.

2.4 Why curriculum changes?

A computer is now seen as an aid to instruction that is permanently available. Computer usage in Mathematics is still low. Many schools may well have computer suites but they are rarely used for Mathematics (Mcdougall & Dowling,1990).

Despite the introduction of a variety of different Mathematics teaching strategies, many of which have their merits, the basis of effective, rather than feel-good, Mathematics teaching remains the drill and practice method. Educators facing larger and larger classes find this the most difficult method of all to apply because it consumes a great deal of educator's time (Mcdougall & Dowling, 1990). The introduction of computers to many schools means that the learner can make use of Mathematics software to practice mathematics problems, leaving the educator free to assist as problems arise, without adding to the educator's working load (Charl,1997).

The first element necessary for the Mathematics revolution is therefore in place in some schools. The capacity to make use of computer-aided Mathematics instruction programs at school allowing learners to practice without increasing the educator's preparation and marking load. The majority of all educational software is based squarely on the current syllabi and is structured according to the syllabus for each school grade. This is a problem in the field of mathematics teaching, since the subject is incremental. It is therefore useless for a learner who has not understood fractions, for instance, to attempt higher-order problems based on the same principle.

For Mathematics instructions to be effective, any program must make it possible for a learner to move backwards and forward easily and confidently through problems which represent varying levels of difficulty in the same area of Mathematics, irrespective of the school grade at which each level of problem is taught (Charl, 1997). This allows a learner who has misunderstood simple concepts early on in his learning of Mathematics to rectify the problem, while allowing another learner to tackle problems well beyond his current grade at school if he / she so wishes.

This approach also removes the stigma of having to go "back" to a lower grade's work in order to rectify a misunderstood section, since programs written in this "open" topic-based style deliberately does not follow the current grade system followed at schools. Programs structured in this manner are effective diagnostic tools, allowing educators to identify and correct underlying problems, and also serve to extend and challengeable pupils. The use of computer technology in the teaching of mathematics enhances

productivity in that a learner is able to tackle a large number of problems in a short period of time and can do so without an educator subsequently having to mark the work (Sadeck, 2001).

Since topic-based programs do not classify the learner according to school grade, learners also quickly overcome their negative attitude towards the subject because they are able to progress from a level at which they are comfortable with and competent in. "This results in increased confidence and better understanding on the part of the learner" (Charl,1997).

The vision of schools in mathematics in the 21st Century is that technology is an essential component of the environment. It also engages educators in helping their learners make, refine and explore conjectures on the basis of evidence gathered in part through the use of technology. But technology does more. It influences the Mathematics that is taught and enhances learner's learning (Neiss, 2002). Researchers(e.g Neiss) have found out that in the 20th Century, learners learned the general equation for a straight line: $y = mx + b$. They learned that m is the slope of the line and b is the y – intercept. They learned these ideas form the educator.

In the 21st Century, things have changed. Learners are able to construct their understanding of linear functions using equation graphing software or graphing calculators. According to Neiss (2002),these technologies offered learners the opportunity to explore their ideas about the symbolic representations of straight line graphs. Both technologies allow beaming or other methods of electronically sharing ideas they are exploring.

Since the 1990's, Dynamic Geometry Systems (DGS) have been increasingly used for teaching, mainly in secondary schools. As the logarithmic tables and the slide rules had been universally replaced by pocket calculators and computers, the traditional Euclidean tools, the ruler and the compass, are still being substituted by virtual tools in computers (Heller, 2002).

The process of solving problems and the analysis of transfer mechanisms have been the two main stays of the cognitive paradigm as it is applied to the study and analysis of Mathematics learning. Hence, in developing our theory of the design of computer-based mathematical instruction, thought was given as to how to represent such processes on computerisable models. According to Heller (2002), the Global Problem Solving (GPS) computer application is the basic historical reference for research into the implementation of the executive-heuristic system in computer application designs.

Heller & Underwood (2002), have highlighted that the teaching of Mathematics has been used as one of the more widely extended conceptual laboratories for proving the efficiency of computer science experiments in teaching and learning. These experiments were used as a basis for may of the Computer Aided Learning (CAL) programs which focused on such topics as arithmetical calculations, geometrical simulations and formal exparisions in algebra.

According to Heller & Underwood (2002), the appearance of the hypertext and that of multimedia and hypermedia systems, have given the rise to new possibilities for the technological implementation of models that carry out and develop capacities

characteristics of the executive-heuristic system. There is a growing consensus that if one receives a good classification and structuring of mathematical information, this will facilitate deeper learning and more efficient learning. Also, it is important to achieve the efficient coding of information, whether verbal, symbolic-formal or in the form of an icon (Heller & Underwood, 2002).

The emergence of hypertext has facilitated the possibility of organising knowledge in a way different from the traditional linearity of the textbook. With hypertext, information can be arranged in blocks, connected by links, through which existing knowledge can be recovered when it seems opportune, in a non-linear way. This structuring seeks to emulate the organisation of the association process of learning.

Loomes & Shafarenko (2001), have outlined that the union of hypertext and multimedia technology, a technology that enables the integration of diverse media (audio, video etc) has resulted in the development of hypermedia, which allows differentiation at the individual user level. These hardware and software developments have been augmented by new understandings of ways in which information can be stored and used. Thus the interactive multi-representation permitted by hypermedia systems allows the possibility of representing dynamic processes for promoting the coding and organising capacity of the knowledge. In short, hypermedia systems now allow good classification and structuring of the information, adequate, storing criteria, significant searching, immediate retrieval of knowledge, multi-representation of information.

Hypermedia systems also provide a series of basic properties essential to teaching and learning processes. They allow the adaptation of each learner. They allow feedback from the system, so that the learner can know whether his/her reply is appropriate or not. To reiterate, hypermedia systems have the means to support constructive learning which surpass the possibilities offered by textbooks (Heller & Underwood, 2002). Such systems improve information and simulation, thus bringing the user closer to actual manipulation and to concrete experience so that the learner can direct learning. They also facilitate social interaction and co-operation.

In the specific case of Mathematics, people would argue that deep learning is not constructed linearly, but rather by forming propositional networks with modes connected to each other by many cross-links of different levels. Such links are more easily represented in hypermedia than a linear book. Let it suffice to recall that when a Mathematics book is used, it is necessary for long-term memory to be activated in order to retrieve the knowledge required to understand what is being dealt with (Heller & Underwood, 2002).

This task, which requires constant alertness and permanent tension, is one of the difficulties that learners find in tackling the study of Mathematics. However, hypermedia systems can be more effective in reducing such cognitive load than books. Mathematical processing is dependent on our memorising ability, especially on storage capacity and speed. Many researchers in the field of mathematical learning (e.g Schoenfeld, 1994) consider that learning how to solve problems is the fundamental objective of Mathematics education.

There has always been an expectation that learners of Mathematics should be able not only to solve problems, but also to explain their answers or show their workings (Loomes & Shafarenko, 2001). With very traditional formal approaches to Mathematics, this often meant little more than learning the socially acceptable norms that accompany particular classes of problems. More modern approaches to teaching Mathematics encourage learners to explore methods, investigate non-standard problems and devise alternative approaches to problems. Technology should not drive practice but should be developed in response to it.

Practise should then be prepared to adopt technology where appropriate. The issue of practicality needs to be addressed. Can Audiograph actually assist educators in their classroom-based teaching of mathematical explanation in a typical school setting? Achieving appropriate audio levels in a noisy classroom can be problematic.

Spreadsheets are common problem-solving tools in the world outside of school and there is no reason that they cannot be used for this purpose in the classroom. Computers are in place in all schools but the poorest of schools are becoming increasingly affordable. They are also becoming easy to use. The development of more powerful processors has enabled programmers to provide software that are increasingly intuitive and user friendly. Educators need to take advantage of these developments and add spreadsheets to their learner's problem-solving.

Learners can communicate their ideas both graphically and symbolically but are not constrained by the tedious work of graphing each equation to see what it looks like(Neiss, 2002). These technologies have some important constraints that educators need to incorporate as they help learners to explore the graphs of straight lines.

Traditional algebra focuses heavily on refining learner's manipulation skills through the use of paper and pencil (Cates, 2002). Algebra is a way of thinking, communicating and reasoning. As educators, we want our learners to be able to understand algebra and use it appropriately. The use of technology during instruction changes the focus from manipulation to understanding algebra as a language (Demana & Waits in Cates, 2002). The graphing calculator can help learners develop understanding about variables, basic concepts of algebra and explore Mathematical topics.

When the Apple Newton was released in the early 1990's, the Concord Consortium recognised that small portable computers had the power to change education (Staudt, 2002). The Newton is a portable computer a learner could hold. Though the first handheld computers lacked educational support, handhelds now emerging are smaller, more powerful and have educational applications in all subject areas. Their potential to improve education is so significant that they are called equity computers. Some refer to them as the low-cost computers that can open the door for all learners to high-quality education.

One of the most exciting advances in handheld computers is the incorporation of wireless communications (Staudt, 2002). Using wireless communication in the form of an infrared beam built into each handheld, learners can share their work with each other and the educator. Beaming has opened up new opportunities in the classroom for collaboration and the learner assessment. Having handhelds allowed learners to independently test theories, collaborate and document their process.

2.5 Programming Languages.

A computer is a series of instructions that the computer follows to perform a task. However, the list of instructions written by a human programmer is quite different from the instructions that the computer actually follows. The programmer's instructions must be translated into electrical signals that the computer can manipulate and process. A computer programming language allows a programmer to write programs using English-like instructions. These instructions are translated into a format the computer can interpret and directly process by a translator. The most common form of translators include assemblers, interpreters.

In the 1970's and 1980's, the influence of theories of discovery learning came to the forefront and simulations and games were used, not least because of their perceived ability to motivate the learner. Parallel to this, a number of programing languages were developed, e.g PASCAL and LOGO, which allowed the learner to take control of the computer. At this time, Mathematics was used as a reference framework for developing

these languages, because of the conceptual proximity between them and the logical or deductive thought proper to Mathematics.

In a hypermedia environment, the set of problems included in the Compact Disc-Read Only Memory (CD ROM) makes it possible to cover a wide range of strategies for solving. e.g graphic representation of the problem. The typology of the problems included in the CD ROM is varied, ranging from puzzle-type problems. The main purpose of this CD ROM is that the learners develop a heuristic style of problem solving. This CD ROM is in the main addressed to Secondary School learners. The CR can be modified for different levels simply through problem selection and also by modifying the offered information (Heller & Underwood, 2002).

In designing this interactive tool, our aim was that learners should learn certain problem solving strategies in the same way as if they were learning them in the classroom with the educator, but with the possibility of adapting them to their own learning rythym (Heller & Underwood, 2002). All the hypermedia elements that appear throughout the navigation of this CD ROM (images, sound, texts etc) were integrated by Macromedia Director, Version 6.5 (Heller and Underwood).This author tool was chosen because it makes it possible for a large number of users to have access so that the multi-platform possibility offered makes it possible to also implement the final production version for Macintosh. With Shockwave technology, the final product can be worked on via the Internet. It also facilitates the creation of simultations and multi-representations of concepts, which are fundamental when strengthening the mathematical knowledge dealt with.

Macromedia Director was chosen because it incorporates its own programming language, Lingo, which allows great interactivity with the user (Thompson in Heller & Underwood, 2002). Lingo is a programming language that is easy to learn and handle. Hypermedia systems in the educational sphere are still in the phase of trial and experimentation. Currently, many of the multimedia applications designed and implemented are just resources conceived and developed as texts, but adapted to computer media. Moreover, considering the teaching methodology of many countries,their use in the classroom would possibly be scarce, generally sporadic as an isolated resource and not included in the usual teaching or learning process.

Curricular changes in the current teaching of Mathematics are focused on processes for solving problems, together with the introduction of new technologies in the classroom. We believe that the designing and implementation of hypermedia applications can favour individual learning processes, and more so in the field of Mathematics, as here with the current CD ROM (Heller & Underwood, 2002)

There are two ID approaches used in teaching Mathematics, namely drills and games. Drills offer learners a method to practice skills with which they are already familiar with. The learner is given the opportunity to convert his / her familiarity and basic understanding (held in short-term memory) into mastery (long-term memory) (Weigh & Crook, 1988). Also a drill allows a learner to deal with a certain application of a skill in a variety of different formats so that all possible variations become familiar and ultimately mastered (Salisbury, 1988).

The key feature of drills is the method of presenting items. The power of the computer makes it possible to use algorithms and pool or queuing strategies to order items (de Lisle, 1997). In a subject like Mathematics, algorithms are important as they make it possible to generate a vast number of uniques items. An example of a drill which teaches Mathematics is CAMI (Computer Assisted Mathematics Instruction). This program randomly generates a multitude of examples for learners to work through. It follows the South African school syllabus, providing exercises from Grade R level up to Grade 12.

It covers all the aspects of the high school syllabus under the following headings: Junior and Senior Algebra, Trigonometry and Geometry and Graphs. Although some features of an ideal drill are absent from CAMI, it meets most of the requirements and it works in that it makes it possible for learners to practice answering problems in Mathematics with increasing efficiency. In the South African context, it can provide an effective way of covering for the lack of educator skills and resources in that it is easily accessed, even by learners new to computers, and it provides a consistent, mathematically correct response to learners.

Drills has some advantages and disadvantages. It save educators from the tedium of repeating items with learners until they reach a level of mastery. It provide learners with a safe environment in which to develop their understandings of specific concepts and techniques that have already been taught, and so can facilitate the development of self-confidence and fluency in a subject. However, one needs to question how useful drills can be in the new South African in view of the insistence of the new curriculum on discovery-based learning(de Lisle, 1997).

Drills are firmly rooted in Behaviorist psychology and fit into the Positivist epistemology. They provide a way for learners to practice rigidly pre-packed sets of skills. There is no attempt to provide learners with means to constructing their own concepts, or a way to connect to concepts to the real life problems in the learner's world (de Lisle, 1997). Although there is feedback, drills are not fully interactive in that they do not provide a resource for exploring a concept by varying the information fed into a problem (Sims, 1995). Either the answer is correct or incorrect.

In CAMI, for an example, the graphing drills do not allow learners to try out different values in equations to see the resulting effect on a graph. Instead they are given many examples of different graphs for which they must calculate the correct values. The danger here is that only the technique is learned, and not the concept.

ID in the new South Africa needs to develop software that is increasingly interactive open-ended and challenging, but which embeds the very principles of constructivist learning, so that learners develop the skills to make them independent and confident in their work (de Lisle, 1997). It need to give learners and educators tools and environments that will enable them to construct constructivism in the first place. There is a role for both drills and games in the teaching of Mathematics. They can serve as transitional methods that build confidence and fluency, that promote enjoyment and discovery. They can lay the foundation for more constructivist programs that can come later.

The call for a literate society presumes that it will contribute to South Africa's social, economic, political, cultural advancement. From this it must be assumed that this includes technological literacy and that the curriculum will reflect the social make up of the country and its people and reflect their social needs. We need to do it as everybody does. As technology includes many things, this case will focus much on the use of computers, as computers are an example of technology.

2.6 Theoretical Framework

A theory is a set of related propositions that suggest why events occur in the manner that they do (Hoover, 1984). Theory is the most advanced and valid knowledge available that can be generalized and applied to many situations. They often establish the framework of the field and helps persons (researchers / practitioners) within the field analyse and synthesize data, organize concepts and principles, suggest new ideas and relations, and even speculate about the future.

The theory the researcher saw as relevant to the study is constructivism theory. Learning is an active process in which learners construct new ideas or concepts based upon their current or past knowledge. The learner selects and transforms information, constructs hypotheses and makes decisions, relying on a cognitive structure to do so. Cognitive structure provides meaning and organization to experiences and allows the individual to go beyond the information given.

In a constructivist classroom, students autonomy and initiative are accepted and encouraged. By respecting student's ideas and encouraging independent thinking, teachers help students attain their own intellectual identity. Students who frame questions and issues and the go about analyzing and answering them take responsibility for their own learning and become problem solvers. The teacher asks open-ended questions and allows wait time for responses. Reflective thought takes time and is often built on other's ideas and comments. The way teachers ask questions and the ways students respond will structure the success of student's inquiry(Hoover, 1984).

Higher-level thinking is encouraged. The constructivist teacher challenges students to reach beyond the simple factual response. He encourages students to connect and summarize concepts by analyzing, predicting, justifying and defining their ideas. Students are encouraged in dialogue with the teacher and with each other. Social discourse helps students change or reinforce their ideas. If they have the chance to present what they think and hear other's ideas, students can build a personal knowledge base that they understand. Only when they feel comfortable enough to express their ideas will meaningful classroom dialogue occur. Students are engaged in experiences that challenge hypotheses and encourage discussion (Hoover,1984). When allowed to make predictions, students often generate varying hypotheses about natural phenomena. The constructivist teacher provides ample opportunities for students to test their hypotheses, especially through group discussion of concrete experiences.

In constructivism, learning occurs because personal knowledge is constructed by an active, a self-regulated learner who resolves conflicts between ideas and reflects on theoretical explanations. Sources of meaning are experiences and context, there is a real world, which we experience. Meaning is imposed on the world by use, there are many meanings or perspectives for any given event. Goal of instruction is not to assure individuals know particular things but construct plausible interpretations of their own.

This theory is based on the premise that we all construct our own perspective of the world, based on individual experiences and schema. It focuses on preparing the learner to problem solves in ambiguous situation. The learner therefore constructs his own conceptualization and solutions to problems. Learner's autonomy and initiative is accepted and encouraged (Seels, 1996).

Constructivists view learning as the result of mental construction. Learners can learn by fitting new information together with what they already know. People learn best when they active construct their own understanding. In constructivist thinking, learning is also affected by the context and the beliefs and attitudes of the learner. Learners are encouraged to invent their own solutions and to try out ideas and hypothesis. They are given the opportunity to build on prior knowledge (Seels, 1996).

The learning environment for constructism theory is that of a learner-centred environment. In this view, learners are active agents who engage in their knowledge construction by integrating new information into their mental structures. The learning process is seen as a process of "meaning-making" in socially, culturally,historically and

politically situated contexts. According to the Information and Communication Technologies in Teacher Education, in s constructivism learning environment, learners construct their own knowledge by testing ideas and approaches based on their prior knowledge and experience, applying these to new tasks, contexts and situations. Integrating the new knowledge gained with pre-existing intellectual constructs. Below is a model of the learner-centred learning environment.

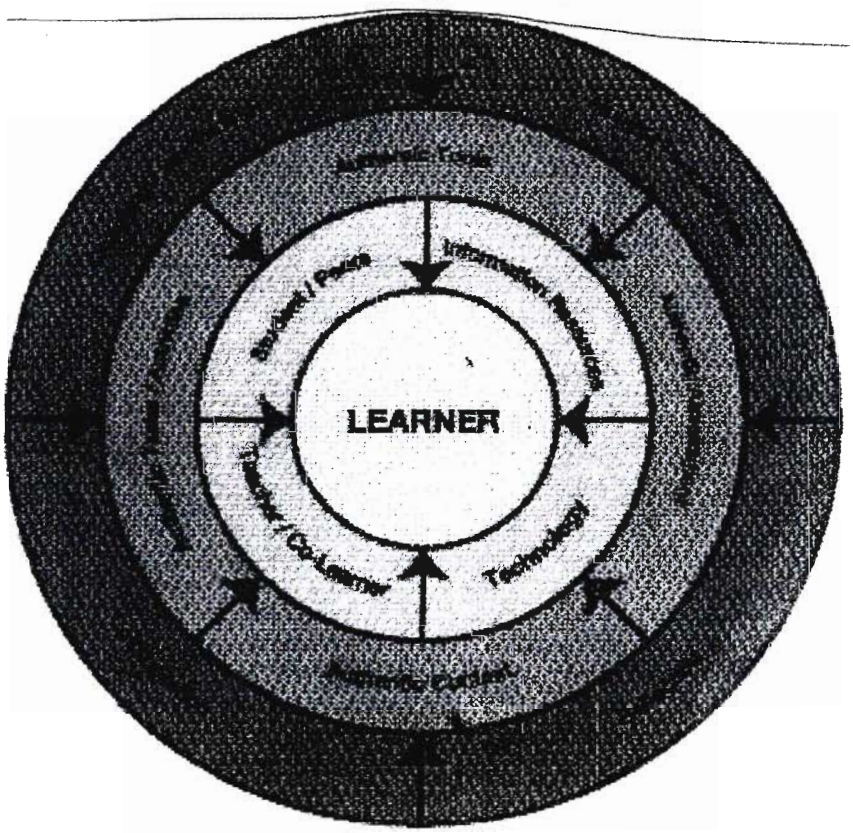

Figure 2.1 Learner-Centred Learning Environment

There are many different schools of thought within this theory, all of which fall within the same basic assumption about learning. The main two are social constructivism and cognitive constructivism. Social constructivism implies that constructivist theory stress

collaboratory efforts of groups of learners as sources of learning and the cognitive constructivists emphasize the exploration and discovery on the part of each learner as explaining the learning process. In this view, knowledge is still very much a symbolic mental representation in the mind of the individual. Constructivism emphasizes learning and not teaching, encourages and accepts learner autonomy and initiative, sees learners as creatures of will and purpose. It thinks of learning as a process.

The literature reveals theories of learning that regard the learners' observations and experiences as the core for learning to occur and see learning as a democratic process that allows for spontaneous activities to be incorporated into this process as well. Theorists like Dewey and Kolb (1963) perceive learners as active beings that need to interact with the world, the world of 'IT', in order to make learning more meaningful and successful.

Dewey (1963) saw schools as democratic places of learning where teachers and learners enjoyed being. I think this will contrast to the way the participants in my study will feel about being in school in which their experiences outside school are isolated from the curriculum. Dewey (1963) also encouraged teachers not to adopt authoritarian stances in schools as this hierarchy hindered the learning process for the learners, as they felt intimidated to truly be them. If educators challenge the traditional boundaries of teacher or pupil relationship and alter their relationships with learners, learners in turn change their attitudes and learning will be enhanced in the classroom.

This theory relates to the use of computers. I say this because in most of the time in computer studies, the teacher supports in pursuing learner's goals. Bereiter (1991) in

Wilson (1997) found that students showed signs of having three kinds of goals:1. Students task-completion goal, 2. Instructional goals set by the system and 3. Personal knowledge-building goals set by the student. Students normally finish tasks that you have given them in class. Pupils would be given a chance to teach each other in class, e.g. if a learner is sure that he understand a thing than others, he is given a chance to help them.

2.7 Conclusion

Bennet (1996) argues that full-computerized schooling in South Africa is not only possible because of the quality of the established infrastructure, but that it is absolutely essential in order to quickly correct the educational legacy of Apartheid, ensure development, cement gains in democracy and prevent inner city difficulties. Our curriculum should be for educational purposes. It should be driven in South Africa by a focus on the development of technological literacy.

Technology is a valuable asset when introducing new concepts in Mathematics. With technology, learners can explore these new mathematical concepts and construct their own understanding. Assessment also takes on new meaning as a guide for instruction. Furthermore, assessment becomes a more appropriate evaluation of learner's conceptual understanding. Technology is an integral part of our society, and the Mathematics classroom offers a wonderful avenue to use it meaningfully (Bennet, 1996).

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter presents the methods and processes that were utilised in obtaining data from a cluster sampling. The researcher felt that it was essential to collect data from the various levels as this would assist in adequately responding to the following critical questions:

- How and why do the educators and learners use mathematics software in teaching and learning mathematics at Phuthaditjhaba High School?

- What value, significance and importance do mathematics software have enhancing learning and teaching at Phuthaditjhaba High School?

Data for the how question was obtained from a participation observation. The researcher choose to use participation observation because it is the only way the researcher can see the way in which the participants use mathematics software in teaching and learning mathematics at Phuthaditjhaba High School. It is easy for the researcher to get answers when she is part of the audience. "The researcher's insight, expertise and understanding is an important element in the research process." (Hokkaido A, 1996)

For the why question, the researcher used the semi-structured interviews with both learners and educators as a method for in-depth probing. The researcher conducted interviews during non-teaching periods or during lunch times. The interviews were informal and began with the researcher attempting to relax the participants and assuring of the confidentiality and of their anonymity. All interviews were recorded by means of tape recorder, with the permission from the participants and transcribed them. Where possible, participants got a chance to read over their transcript to make sure that the researcher has correctly recorded what the participants stated.

For the critical question number two (2), the researcher used questionnaires. The educator questionnaire was designed with the intention to firstly ascertain biographical data of the educator(See Section A- appendix 1). There are things that limited the researcher in this methodology. Time constraints is one of the main difficulties that someone can face as you can find that your participants are not available when you are and vice versa. A school runs its own timetable and it is the researcher's duty to slot her in accordingly. Sometimes, the researcher was told that learners were writing tests or examinations.

3.2 Research approach

An electic approach was utilised, which incorporated ideas and methodologies from a variety of spheres and levels. A multi-tired approach in terms of research methodology was utilised, i.e.:

- qualitative research
- a case study

3.3 Qualitative Research Methodology

In this study, a qualitative research methodology was used. Qualitative research is defined as an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting (Creswell, 1998). In qualitative research, the researcher accepts the research setting as it is, and attempts to understand the situation without imposing his/her preconceived expectations on the study. The aim is to understand phenomena in their natural contexts and to explore the subjective values, beliefs and thoughts of the individual respondent (O'Connell & Layder, 1994).

In qualitative research methodology, the language of the subject is important. This implies that the actual words of the subjects are thought to be critical to the process of conveying the meaning systems of the participants, which eventually become the results or findings of the research (Filstead, 1979). In other words, whatever subject say (during interviews), is crucial since it allows the researcher to discover whatever is important and meaningful to the subject in the study. The researcher's discoveries are presented as the findings of the research. These findings are then discussed and conclusions or implications for the study are drawn.

Qualitative researchers believe that human experience cannot be quantified numerically. Since the experience of using computers in teaching and learning of mathematics is a complex issue which by no means can be expressed in numerical terms, qualitative research methodology was employed for the purpose of this study. Qualitative research allows events to be captured through the words of the subject and the intention of this research methodology is to "disclose and reveal, not merely to order and predict" (Van Maanen, 1979). Sociologist, John Lofland (cited in Patton, 1980), claims that there are four elements in collecting qualitative data, namely:

- The qualitative methodologist must get close enough to the people and situation being studied to be able to understand the depth and details of what goes on ;
- The qualitative methodologist must aim at capturing what actually takes place and what people actually say: the perceived facts;
- Qualitative data consist of a great deal of pure description of people, activities and interactions;
- Qualitative data consist of direct quotations from people, both what they speak and what they write down.

In this study, the researcher found it appropriate to use the qualitative approach since this approach enabled her to understand people in their own terms. Qualitative research provides an insight into the life world of people under study.

3.4 Research Methods

The research method included semi-structured interviews and questionnaires.

3.4.1 Semi-structured Interviews

Semi-structured interviews were used in this study. A semi-structured interview is an interview whose purpose is to obtain descriptions of the life world of the interviewee, with respect to interpreting the meaning of the described phenomena (Kvale, 1996). During the semi-structured interview, the researcher introduced the topic of the interview, asked pertinent questions and followed up new leads depending on the interviewee's responses to her questions. Semi-structured interviews were conducted with one educator of mathematics and all Grade 12 learners of Phuthaditjhaba High School.

3.5 The school context

The study was conducted at Phuthaditjhaba High School- an educational school which is situated in the rural areas of Matimatolo, approximately 30 km from Greytown. In 2005 the learner intake at this school is 1011, with the total staff (all African), being 27.

The learner population at the school is made up of Africans only, belonging to the lower socio-economic group. Presently, the school fee at Phuthaditjhaba High School is R140.00 per learner, per annum.

3.6 The Research Process

The sample that was used in this study were from:

- Learners (table 3.1)

Table 3.1 Learner sample used in the study

Table 3.1 Learner sample used in the study.

Grade 12

Area	*Number of learners*
Lilani	1
Mbulwane	5
Mbuba	4
Greytown	1
Shane	1
Matimatolo	9
Ntembisweni	1
Total	**22**

The table above shows that learners from Phuthaditjhaba High School come from various rural areas. The researcher found that most learners are coming from Matimatolo area, as the number shows that there 9 learners. There are only 5 learners from Mbulwana, 4 learners from Mbuba. The minority of the class come from Lilani, Greytown, Shane and Ntembisweni, only 1 learner from each of these areas.

- Educator (3.2)

The details of the educator in this study appear in Table 3.2

Table 3.2 Sample used in the study

Educator Sample	*Age*	*Learner Sample*	*Race*	*Teaching Exp.(Years)*	*Qualification*	*Date*	*Location*
Educator 1	*34*	*22*	*African*	*9*	*STD-Esikhawini College of Ed. HDE- UNISA*	*03/02/05*	*Greytown*

The table above give the details of the educator who was the participant in this study. There was only educator participating because he/she was the only one teaching the class. She/he is 34 years old and an African. She/he has been teaching mathematics for 9 years. She/he got his/her teaching qualification (STD) at Esikhawini College of Education and further his/her studies (HDE) in UNISA. The data for the educator was collected in 03/02/2005 in Greywton

3.6.1 Selection of Participants

The participants in this study included one mathematics educator and the whole class of Grade 12. All the participants were approached for the research. All of them willingly consented to participate in the research. They were assured of confidentiality and anonymity.

3.7 Conclusion

Through technology, educators must aim to give every learner the opportunity to develop skills which will give equal access to employment in adult life. Learners should leave school knowing exactly how is the world outside school, what is expected of them. In the next chapter, the researcher is going to show how she analyzed the data.

CHAPTER 4

DATA ANALYSIS / FINDINGS & INTERPRETATION

4.1 Introduction

The aim of this chapter is to contextualise the methodology described in chapter 3, and to show the analysis of the data. This chapter also presents the summary of the data that was collected from the learner questionnaires, as well as from the educator (responses from the mathematics educators). All questionnaires were filled in by learners, therefore the response rate with this regard was 100%. They were filled in the year 2005, when Grade 12 learners were given the opportunity to use the software in order to improve their attitude towards mathematics.

In chapter 3 of this study indicates that 3 types of research tools of gathering information were used; i.e .interviews, observation and questionnaires. The information gathered through this process is accompanied by a detailed interpretation. When interpreting and analysing data, the researcher used qualitative method. Qualitative data was gathered through an interview that was carried out for the educator and observation. The chapter concludes with issues arising from the analysis of the data.

4.2 Participant's Profile

It was noted that 70% participants from the school are the inhabitants from Matimatolo area, in which the school is situated. The biggest problem of the participants (learners), of this study was that, most of them come from family backgrounds where the parents are totally illiterate and poor. Therefore, parents could not assist or contribute anything formally towards the education of their children. The sample consisted of an educator and 22 learners. In response to question 3 of the questionnaire, it can be ascertained that there were 14 males and 8 females, which is representative of the female, male ratio in the classroom.

4.3 Presentation of data

The basic aim of the research report is to communicate the findings as simply and directly as possible. Above all else, the writing should be marked by clarity and accuracy (Warwirck & Lininger, 1975). A method of communication is needed by the researcher when he/she wishes to describe the sample or present evidence of an association or difference between variables. Tables, graphs and figures must be used to make concise presentations of the statistical decision-making information. To make concise presentation, the researcher have chosen to present the data graphically as well.

4.4 Tables and figures

According to Adams & Schavaneveldt (1985), tables are the most frequently used medium of communication in the presentation of data. Any form of description or inferential statistic can be presented in a tabular form. Tables consist of an interrelation between rows (running horizontally)and columns (running vertically). Tables are a simple,concise medium for the presentation of data. In certain forms of data, it is useful to

highlight information through the use of pictorial presentation, called a figure (Adams & Schavaneveldt, 1985). The figure offers simplicity and a dramatic effect on the comparison between factors. A frequently used figure is the pie chart. The pie chart is a circle divided up according to the proportion of each item's weight. A pictorial representation of figures and graphs, which are divided by combining the row and column dimension of the table. The common types of graphs used are the line graphs and bar graphs. All of these representations are included in this chapter.

4.5 Presentation of interview schedule : Educator

Semi-structured questions were used. This was simply chosen for its objectivity, open-endedness yet specific intent. The researcher also chose this tool because she/he felt that semi-structured questions allows different individual responses, probing, follow-ups and clarifications.

4.5.1 Presentation of sections A: General information

The researcher needed information from the respondent regarding teaching experience, teaching qualification, number of years in the present school and position held at school. It was found that the participant have been in the educational field for a considerable time, and is still energetic and can bring about some changes and transformation in education. The data below is for the educator.

Table 4.1

Teaching experience	9yrs
Present school	5yrs
Position held	HOD
Teaching Qualification	HDE

The table above shows that the educator has taught for 9 years and at Phuthaditjhaba High School he/she has taught mathematics for 5 years. The participant is an HOD (Head of Department) in Science stream. The highest qualification that the educator has is the HDE.

4.5.2 Presentation of section B of the Interview Schedule

Questions 6-11, open-ended questions, and were designed to give the respondent an opportunity to express his/her views on the introduction and use of the mathematics software in the school.

6. What is your opinion of the use of mathematics software?

   The respondent saw this software as something which is helpful, to both the educator and the learners in the teaching and learning of mathematics. The participant said that is something that should be practiced by the whole school (from Grade 8-12), but because the school does not have enough computers, they cannot introduce it all grades but in the future, the school must see to it that it buys more computers and let all learners use the computers.

   7. Do you think it is wise to use the software in Grade 12 other than introducing it to Grade 10 learners?

   The respondent said that they introduce it only to Grade 12 learners because they do not have enough computers and they are targeting Grade 12 learners because they want a high pass rate at the end of the year. The other thing that the respondent said was that it was easy for him/her to let the Grade 12 learners use this software because they were a small number, so is was successful, and learners were able to communicate with the computer.

8. Is there any improvement in teaching and learning of mathematics since the introduction of the use of this software?

   The respondent said yes and she/he ellaborated his/her answer by saying that most of learners are now having a positive attitude towards mathematics since they used this software. Even in their activities, e.g. Tests, class works etc, there is am improvement. "60% of learners pass it with flying colours and those learners are the ones whom you always find in the computers practising mathematics, said the participant."

9. Do you think the software make learners practice their skills efficiently?

   The participant said that learners still need more time to practice their skills. She/he said that the time allocated to the use of this software is not sufficient for the learners, they need more time. Their skills need to be improved a lot. Although there are those few individuals who are good in using the software, almost 70% of the learners need to be given more practice.

10. Should there be more time and emphasis placed on the use of the software?

    The participant said that learners still need more time to practice their skills. She/he said that the time allocated to the use of this software is not sufficient for the learners, they need more time. The respondent said that emphasis must be put, more especially to those learners who are doing Grade 10, so that when they do Grade 12, they just excel everything.

11. Is the use of the software helps learners to be more competitive when they are with other learners from neighbouring schools?

    The respondent said that learners do well when they are with other learners. She/he

even made an example when 5 learners when asked to help learners from one neighbouring school. She/he said that they were doing good . What helped them is their eagerness to use the software.

4.6 The use of Questionnaires

For critical question 1, the questionnaire was used. The questionnaire used for this occasion was based on:

- personal reaction or feeling towards the use of mathematics software in teaching and learning process.
- Future recommendation by learners towards the use of mathematics software.

4.6.1 Presentation of sections A: General information

The researcher needed information from the respondent regarding their age, gender and race. Thus for this particular study, learner perceptions on their experiences of mathematics teaching and learning were explored, to determine the extent to which the teaching/learning environment may be contributing to their usage of mathematics software.

4.6.2 In their questionnaires, learners outlined their feelings towards the subject mathematics and their experiences of mathematics lessons at in Grade 12.

4.6.2.1 Attitudes towards mathematics as a subject.

60% of learners are exceptionally negative about their experiences of mathematics at Grade 12. 20% of learners indicated that they have an aversion for mathematics. 20% of learners indicated that mathematics is difficult and 60% indicated that they do not understand mathematics. Some of the learner's response were:

"Mathematics is hard. The educator goes fast. I do not understand the work and I do not even understand the questions."(Nomathamsanqa)

"I hate mathematics since too much of work is pushed in one lesson and I cannot make sense of it"(Sambulo)

4.6.2.2 Learner perception of the teaching / learning environment.

Learners saw the learning environment as the one which is relaxed. They even suggested that they wish the as from Grade 8, all learning doing mathematics should be introduced to the use of this software. They said that they think if this was done, they will be low failure rate of mathematics even from the beginning. They said that they enjoy an environment like this because they are (learners) the ones who are the center of teaching and learning, and the teacher become the facilitator. This kind of thing make them (learners) active learners and eager to learn more.

4.6.2.3 Educator's Approach to mathematics lesson

The educator lets learners participate a lot. Most of the work is done by learners. The educator said that he/she has moved away from a jug and mug method. Learners become active learners. They participate in whatever thing is done in class. The educator act as a facilitator, demonstrating to learners what to do if there is something that they are not clear with.

4.7 Observation

The researcher observed learning and teaching in this class. This is what the researcher found out. Learners were given time to express themselves and in most cases, they were the drivers of the lesson. The educator was a facilitator not, a teacher. Time allocated for the period was not enough because when practising, learners needed more time and only to find that the bell rang soon.

The were few computers so now learners were to share the computers. By so doing, they did not have time to practise on their own.

4.8 Conclusion

The information gathered in this study is more interesting in the sense that unexpected issues came up. The use of triangulation approach yielded very good results and from what has been discovered, it then became clear that there is a lot to be done in order to help our learners in schools.

CHAPTER FIVE

FINDINGS DISCUSSION

5.1 Introduction

In the previous chapter the findings of the research was presented. This chapter attempts to discuss the findings. The following findings respond in more than one way to the critical questions asked in the study.

5.2 Linkages between the theory and the questions

The theory the researcher saw as relevant to the study is constructivism theory. According to Hoover (1984), in a constructivist classroom, learners autonomy and initiative are accepted and encouraged.

5.2.1 Learner : According to Hoover (1984), learning is an active process in which learners construct new ideas or concepts based upon their current or past knowledge. Even in this study, learners were given the opportunity to express themselves. They were the ones who were the centre of teaching and learning, and the educator became the facilitator. Learners were given the chance to practice and improve their skills. Learners were the driving force. Education was in their hands. That's is why the constructivism theory emphasise that learner's ideas must be respected so that they feel free to construct their own knowledge and ideas. Again, in this theory, learners are encouraged in dialogue with the educator and with each other. The researcher found that most of the time learners were engaged in a dialogue with their educator. That is why learners find the teaching and learning environment relaxed.

5.2.2 Technology: According to Seels(1996), learners can learn by fitting new information together with what they already know. That is why the respondents showed a positive attitude when asked these questions:

Pupils: Do you think that there should be more emphasis placed on practical use of mathematics software than on theory?

Educator: Is the use of the software helps learners to be competitive when they are with other learners from neighbouring schools?

Because it showed that learners use the knowledge that they gained from using the software and they one that they obtained in the lower grades or the one that they already knew. This make them positive learners and be more competitive when they are with learners from other schools. The researcher find that learners do not only take what they learn using the software and forget about what they already know.

5.2.3 Information Resources : Phuthaditjhaba High School is located in the rural areas of Matimatolo area. Most of the learners are coming from disadvantaged backgrounds, even the school is still developing, so now learners do not have access to libraries, resource centres. The researcher find that there is a need for the opening of such education centres so that learners can use after hours. A learners must familiarise her/himself with the resources even outside school. Even the school have not enough computers for learners to be able to use this software.

5.2.4 Facilitator / co – learner : Dewey (1963) encouraged educators not to adopt authoritarian stances in schools as this hierarchy hindered the learning process for the learners, as they (learners) felt intimidated to truly be them. The researcher found that the educator was regarded as a facilitator, helping learners where there was a need. The environment provided learners with coaching in developing know

5.2.5 Student / Peers : The learner – centred environment shows that the learner interacts with other learners. A constructivist learning environment provides opportunities for learners to experience multiple perspectives. Through discussion or debate, learners are able to see issues and problems from different points of view, to negotiate meaning and develop shared understandings with others. From the findings, the researcher find that learners do not have enough time to negotiate and have debates amongst themselves, regarding the software as time allocated is not enough. They do this with the educator but not with themselves. There is a need for learners to be given this opportunity.

5.2.6 Authentic tools : In the Planning Guide offered by UNESCO, learners must be provided by the tools to help them access vast knowledge resources, collaborate with others and share knowledge. In this school, this is a disaster because the school does not have tools for learners to do this. The researcher find that the school need to be sponsered by the tools. That is why the respondents answered negatively in this question:

Educator : Do you think it is wise to sue the software in Grade 12 other than introducing it to Grade 10 learners? The respondent said that they do not have enough computers, even in Grade 12, some of the learners share a computer.

5.2.7 Authentic Assessment : The researcher find that the educator is trying by all means to apply this form of assessment but management of the school is against it. They believe in paper work so now the educator is doing have level best to do the two forms of assessment. The respondent said that it is too much taxing. The researcher thinks that the educator must do what will be a success at the end.

5.2.8 Authentic Context : Learners saw the learning environment as the one which is relaxed. From this answer, the researcher concluded that is this environment which leads to a high pass rate in the classroom because learners feel free to ask questions and come up with their own ideas and suggestions.

5.2.9 Authentic Tasks / Activities : Learners were engaged in aunthentic tasks and most of the time they deed them on their own. They enjoyed the tasks because they were practical. From this, the researcher realised that learners participate more on practical work than on doing homeworks, tests and assignments. The educator told the researcher that learners participated in whatever activity given in class. This is a sign of active learners, concluded the researcher.

5.2.10 Collaboration : According to Seels (1996), the construcivist teacher provides ample opportunities for learners to test their hypotheses, especially through group discussion of concrete experiences. From the findings, the researcher found that learners are not given enough time for discussions and group work because of time allocated for the subject. At least in an hour, learners should be given 15 minutes to exchange ideas and knowledge.

5.2.11 Coaching : The researcher found that the educator is acting as a facilitator, not as a teacher. Most of the work is done by learners and the educator is coaching them. The educator has moved away from a jug and mug method. Is as if he/she is in a s soccer match., coaching the players and at the end of the day expecting them to win.

5.2.12 Multiple Perspectives : The researcher found that learners do not have time to come together and share the ideas. Sometime they do but when the educator has asked them to do, is not something that they usually do.

Learners must be encouraged to share ideas as it help a lot.

5.2.13 Reflection : Learners are give time to reflect on their learning. After each and every task or activity, the educator let learners see how they have done. They are given a chance to evaluate themselves and correct their mistakes.

5.3 Answers to the critical questions: For critical question number one, the researcher found that the mathematics software is used in order for learners to be competitive when they are with other learners from other schools. And again, in order for the learners to get used in using this software and prepare learners for the future. For critical question number two, the researcher found that there is an improvement with the performance of learners doing mathematics in Grade 12. There is a high pass rate in mathematics since the introduction of this software. As the respondent even said that 60%of learners pass mathematics with flying colours.

5.4 Conclusion

The researcher is of the opinion that this study could make a positive change to the school based on the findings.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

In the previous chapter, the findings of the research was presented. The researcher has noted that the use of mathematics software in most rural schools is something that is uncommon.

6.2Recommendations

6.2.1 The use of the software by the whole school

Often use of mathematics software in teaching and learning at Phuthaditjhaba High School should be encouraged. Learners see it as something that is very useful, because it makes things clearer and easier for them to understand. The researcher thinks that this software must be used by the whole school, from Grade 8 to Grade 12.

6.2.2 Availability of resources

The researcher found out that the school is under section 21, that means that government do give it the money for norms and standards. For this software to be accessible, the school must but more computers and programme the software to all. Again, the school must build a computer laboratory which will accommodate at least 50 learners because the lower grades (Grade 8-9) are in large numbers so they cannot fit in the present computer laboratory.

6.2.3 Educator-empowerment

As there is only one class using the software and one educator teaching them, more educators are needed since they software will now be used from Grade 8 upwards. Even in a classroom, if there are about 50 learners in the computer laboratory, it will be difficult for 1 educator to teach such a big class. An educator will need an assistant. Learners will be able to get everything that the educator instruct them to do, some will be left behind, some will do their own things since they know that the educator will not be able to see them. If it is like this, at the end, learners would fail because they did not grasp anything.

6.3.4 Visiting the computer laboratory during spare time

Learners should be encouraged to use the computer laboratory during their spare time. They must not rely on the educator, they have to come on their own and practice. This is recommended because you may find that during the period itself, learners did not practice to their fullest, so they must create their own time and practice more so as to achieve at the end.

6.2.5 Accessibility to the computer laboratory

The computer laboratory must be opened for the whole day. At least for 7 hours (from 8am-3pm). The researcher say this because you may find that sometimes the computer laboratory is closed, during school hours. Even if learners are willing to use the computer laboratory they cannot because they do have access.

6.2.6 Internet in school

The school management must apply for the Internet because it can help learners with the software that they use. They visits sites and learn.e.g sites related to mathematics and other subjects. The Internet would not only help them in mathematics only. Because it is

user friendly, they will find themselves having a positive attitude towards their education and encouraged.

6.3 Conclusion

Phuthaditjhaba High School with a working computer laboratory is certainly not using the laboratory for maximum gain. Only a few privileged Grade 12 learners doing mathematics and those doing computer studies use this laboratory and at other times closed. The cost of setting up such a laboratory is enormous and for it to service just a minority of the school's population is a serious injustice and shortcoming. Different softwares that the school has are a powerful tool for learning and improving education, since they creates opportunities for learning from cross-national and cross-cultural comparisons.

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Information and Communicstion Technologies in Teacher Education. A Planning Guide

APPENDIX 1

EDUCATOR QUESTIONNAIRE

To Whim It May Concern

I.....(full name of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

Signature of Participant ..... Date .....

EDUCATOR INTERVIEW SCHEDULE

(a) The aim of this section is to ascertain biographical data:

1. Name of School:_____

2. Age :_____

3. Race :_____

4. Gender : Male

☐

Female

☐

5. State teaching qualification:_____

_____

_____

6. Position:_____

7. Number of years teaching mathematics:_____

8. Number of years in the present school:_____

(b) The aim of this section it to establish the learning and teaching of mathematics software:

6. What is your opinion of the use of mathematics software:_____

_____

_____

7. Do you think is wise to use the software in Grade 12 other than introducing it to Grade learners?

8. Is there any improvement in teaching and learning of mathematics since the introduction of the use of mathematics software:

9. What do you think is the cause thematics results at matric level?

10. Do you think the software make learners practise their skills efficiently?

11. Should there be more time and emphasis placed on the use of the software?

Or

Is the teaching and learning of mathematics balanced in terms of theory and the use of the new software?

_____

_____

(c)Competency (perceptions of competency levels

11.Is the use of the software helps learners to be competitive when they are with another learners from neighbouring schools?

_____

_____

_____

_____

12. Can the learner be able to do B.SC after completing Grade 12 with the experience that he/she has?

_____

_____

_____

_____

(d)General:

_____

_____

APPENDIX 2

PUPIL QUESTIONNAIRE

Aim: To ascertain your impressions and opinions of the use of the mathematics software.

(a) Biographical Data:

1. Name of School:_____
2. Age :_____
3. Gender : Male

   ☐

   Female

   ☐
4. Race :_____
5. Which area do you reside in?_____

(b)Curriculum:

6 Have you ever received any mathematical support before? Please Tick.

a) At home,

b) At school,

c) Anywhere within the community?

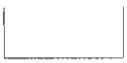
7. Do you enjoy this subject in the way that it is structured?

Yes

No

8. Do you think that there should be more emphasis placed on practical use mathematics software than on theory?

Yes



No

Or

8. Do you think that there should be more emphasis placed on mathematics theory than on the use of the software itself?

Yes

No

9. Is the number of hours spent per week on the software adequate?

Yes

☐

No

☐

If No, could you specify the number of hours that should be spent on the software per week?_____

10.Should there be any changes made of the application of the software?

Yes

☐

No

☐

If Yes, what changes would you prefer made?

_____

_____

_____

_____

(c)General:

11.Could you briefly explain one moment or experience that you had during the learning and teaching using this application software:

_____

_____