

**INTEGRATING TECHNOLOGY INTO THE LEARNING AND
TEACHING PRACTICE**

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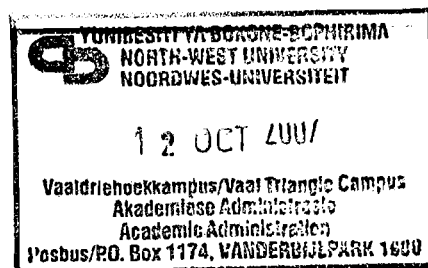
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Philippians 1:6 “He who began to do good work in you will carry it on into completion”.

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SUMMARY

The aims of this research were to:

- investigate the nature of technology integration into the teaching and learning practice;
- investigate ways in which schools have integrated technology into learning;
- investigate ways in which schools have integrated technology for professional development of educators;
- investigate if there is an equitable accessibility of technology to learners in schools;
- investigate if necessary resources are available to implement technology in schools; and
- make recommendations for schools to integrate technology into their teaching and learning curricula.

To achieve these objectives, this research used, firstly, a literature review in order to explore both the national and international literature findings on the scholastic work of researchers on the integration of information technology in teaching and learning settings. Secondly, an empirical research method, which consisted of both the quantitative and qualitative research approaches, was conducted to find out the way in which schools in South Africa, with particular reference to schools in the Vaal Triangle area, have made efforts to integrate computer technology in their teaching and learner curricula.

The findings from the literature study revealed that primary school learners who received brief daily computer-aided teaching lessons as a supplement to teaching showed gains equivalent to between one to eight months of teaching over their peers who received traditional teaching only. Various researchers also reported increases in learner attendance, motivation and attention span.

Computer technology, according to the literature, can also be very accommodating, for example, computers can reach learners at different study ability levels, any time of the day or night. Additionally, the sense of independence, self-regulation and accomplishment a computer offers helps learners fuel their self-confidence and self-regulated learning.

The quantitative empirical research findings revealed that educators and school management teams do not understand their unique roles in the integration of computer technology in the school curriculum; and educators lack knowledge and skills needed to incorporate computer technology in teaching and learning activities on a classroom-wide basis.

The findings of the qualitative research method revealed that schools do not have a mandatory obligation to enforce the teaching of computer technology to their learners; educators lack computer technology skills; there is a great need for an intensive training of educators on computer technology and the various softwares which are available for educators in various learning areas; computer technology has capacity to enhance educators' efficient and effective school, class and learning area administration, including their personal professional development; School Management Teams need to concertedly manage the integration of computer technology into the teaching and learning situation and thereby empower educators through workshops, skilling, and reducing learner: educator ratio in computer technology classes;

Recommendations are made which emphasise the need for a comprehensive capacity-building programme for educators on computer technology and its integration in the school curriculum.

OPSOMMING

Die doelstellings van hierdie navorsingstudie was om die volgende te ondersoek:

- die aard van tegnologie-integrering in die onderrig- en leerpraktyk;
- die wyse waarop skole tegnologie in die leerproses geïntegreer het;
- die wyse waarop skole tegnologie geïntegreer het in die professionele ontwikkeling van opvoeders;
- die wyse waarop daar gelyke toegang tot tegnologiese hulmiddels in verskillende skole bestaan;
- die nodige hulpbronne wat in skole beskikbaar is om tegnologie te integreer; en
- watter aanbevelings gemaak kan word om te verseker dat skole tegnologie effektief in die onderrig- en leerproses en vir die implementering van die kurrikulum aanwend.

Ten einde die doelstellings te bereik, is daar eerstens 'n literatuurstudie onderneem om te bepaal hoe die integrering van tegnologie in die onderrig- en leersituasie wêreldwyd deur navorsers ervaar is. Tweedens is beide 'n kwantitatiewe en kwalitatiewe empiriese ondersoek gedoen om te bepaal tot watter mate skole in die Vaaldriehoek daarin geslaag het om rekenaartegnologie in hulle onderrig- en leersituasie te integreer.

Uit die navorsingsbevindinge het dit geblyk dat laerskoolleerders wat daaglik aan kort rekenaarondersteunde onderrigssessies blootgestel is, se prestasie op 'n vlak van een tot agt maande hoër presteer as diegene wat slegs aan tradisionele onderrig- en leerpraktyke blootgestel is. Verskeie navorsers het ook by die groep wat aan rekenaarondersteunde onderrig blootgestel is, hoër aanwesigheidsyfers en beter motivering en konsentrasie gevind. Uit die literatuurstudie blyk dit dat rekenaartegnologie baie akkommoderend is ten opsigte van die verskillende vlakke waarop leerders hulle bevind en ook ten opsigte van groter toeganklikheid deur die dag en nag. Bykomend daartoe lei die toepassing van rekenaartegnologie tot groter onafhanklikheid,

selfregulering en suksesbeleving en dra daardeur by tot groter selfvertroue by die leerder en ook selfregulering.

Uit die kwantitatiewe ondersoek het dit geblyk dat opvoeders en skoolbestuursliggame nie bewus is van die belangrike rol wat hulle kan speel om rekenaartegnologie by die skool se onderrig- en leerprogram te integreer nie. Daar is ook bevind dat opvoeders nie oor die nodige kennis en vaardighede beskik om rekenaartegnologie in klaskameraktiwiteite te integreer nie.

Uit die kwalitatiewe ondersoek het dit geblyk dat skole nie 'n mandaat of verpligting het om rekenaartegnologie aan leerders te onderrig nie, opvoeders beskik nie oor vaardighede in rekenaartegnologie nie, daar bestaan 'n groot behoefte aan die intensiewe opleiding van opvoeders in rekenaartegnologie en in die aanwending van die verskillende sagteware-pakkette wat in verskeie leerareas beskikbaar is. Die aanwending van rekenaartegnologie is bevorderlik vir meer doeltreffende en effektiewe skool-, klaskamer- en leerarea-administrasie en vir die professionele ontwikkeling van die opvoeder. Skoolbestuursliggame moet op 'n beplande wyse die integrering van rekenaartegnologie in die onderrig- en leersituasie beplan en bestuur en met die oog daarop moet opvoeders bemagtig word deur werkswinkels, vaardigheidsopleiding en deur 'n vermindering van die opvoeder: leerder ratio in rekenaartegnologielokale.

In die studie word bepaalde aanbevelings gemaak vir 'n komprehensiewe kapasiteitsbouprogram wat opvoeders in staat sal stel om in rekenaartegnologie bemagtig te word en om dit effektief by die implementering van die kurrikulum te integreer.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	ii
SUMMARY.....	iii
OPSOMMING	v
TABLE OF CONTENTS.....	vii
LIST OF TABLES	xiv
LIST OF FIGURES.....	xv
CHAPTER ONE ORIENTATION.....	1
1.1 INTRODUCTION	1
1.2 STATEMENT OF THE PROBLEM.....	6
1.3 AIMS OF THIS RESEARCH.....	8
1.4 METHODS OF INVESTIGATION	9
1.4.1 Literature study.....	9
1.4.2 Empirical research.....	9
1.4.2.1 Sample of this research	9
1.4.2.2 Target population.....	10
1.4.2.3 Accessible population	11
1.5 ANALYSIS OF EMPIRICAL DATA	11
1.6 CHAPTER DIVISION	11
1.7 CONCLUSION.....	12
CHAPTER TWO LITERATURE REVIEW.....	13
2.1 INTRODUCTION	13

2.2	CLARIFICATION OF CONCEPTS	14
2.2.1	Computer Based Education.....	14
2.2.1.1	Computer Assisted Instruction (CAI).....	14
2.2.3	Instructional technology.....	17
2.2.6	e-Learning Tools	21
2.3	TECHNOLOGY INTEGRATION	21
2.4	FORCES OF CHANGE AS THE THEORETICAL FRAMEWORK OF THIS RESEARCH.....	27
2.4.1	Identification of restraining forces.....	28
2.4.2	Lessons from educational technological past.....	30
2.5	THE CURRENT STATUS OF CLASSROOM TECHNOLOGY.....	31
2.6	EDUCATORS AND TECHNOLOGY.....	34
2.6.1	Instructor	36
2.6.2	Coach.....	36
2.6.3	Model	37
2.6.4	Critic	<u>37</u>
2.7	THE LINKS BETWEEN ICT AND LEARNING AND TEACHING.....	37
2.7.1	Learning about ICT - computer and ICT literacy.....	37
2.7.2	ICT-assisted learning: ICT as a tool.....	39
2.7.3	Learning by means of ICT: ICT as an educational resource.....	39
2.7.4	ICT as a building block of a powerful learning environment.....	42
2.8	ICT IMPACT ON THE SCHOOL ORGANISATION.....	43

2.8.1 Staff policy.....	44
2.8.2 ICT policy strands.....	45
2.9 The vision of integrating ict in teaching and learning situation in south africa	48
2.10 INTEGRATING COMPUTERS INTO THE CLASSROOM.....	53
2.11 PRINCIPLES OF GOOD PRACTICE for integration of technology in teaching and learning.....	54
2.11.1 The need to shift from 'education for ICT' to the use of 'ICT for education'	54
2.11.2 The need for ICTs to be integrated across the curriculum.....	56
2.11.3 The need for relevant and locally produced content.....	56
2.11.4 The need for real partnerships	57
2.11.5 The need to build sustainability into programmes from their inception.....	58
2.12 computer Illiteracy and literacy.....	59
2.12.1 Factors that lead to computer illiteracy.....	59
2.12.2 Steps towards achieving computer literacy	64
2.12.2.1 Making computer literacy happen.....	67
2.13 COMPUTERS AS e-LEARNING TOOLS	68
2.13.1 Computers as creative tools	70
2.13.2 Computers as productive tools	70
2.13.3 Computers as research tools.....	70
2.13.4 Computers as communication tools	71

2.13.5 Computers as entertainment tools.....	71
2.14 INTEGRATED LEARNING SYSTEMS VERSUS TRUE INTEGRATION	72
2.15 EXAMPLES OF COMPUTER USE IN INTEGRATED CURRICULA.....	73
2.16 South African Curriculum 2005, the integration of computer technology, and some major landmarks of ICTs in education in South Africa	74
2.16.1 The Technology-Enhanced Learning Investigation framework and its role in addressing ICTs in the South African education system.....	75
2.16.2 Centre for Educational Technology and Distance Education	76
2.16.3 Vision of a national educational technology network.....	78
2.16.4 Conceptualising and launching of the SchoolNet South African project	79
2.16.4.1 Monitoring and evaluation of SchoolNet South Africa's activities	81
2.16.4.2 Networking and shaping of computer technology and ICT's activities IN AFRICA	84
2.16.4.3 Developing technical services	84
2.16.4.4 Providing SchoolMail.....	85
2.16.4.5 Managing domain administration.....	85
2.16.4.6 Providing Website hosting.....	85
2.16.4.7 Providing leased-line connectivity	85
2.16.4.8 Net-Day	86

The study by SchoolNet South Africa has found that at Katlehong High School:.....	87
2.17 CONCLUSION	88
CHAPTER THREE EMPIRICAL DESIGN	89
3.1 INTRODUCTION.....	89
3.2 RESEARCH METHODS AND CHOICE OF THE INSTRUMENT	90
3.3. RATIONALE FOR CHOOSING THE QUALITATIVE As well AS QUANTITATIVE RESEARCH METHODS	92
3.3.1 The qualitative method	92
3.3.2 The quantitative method.....	94
3.4 CHARACTERISTICS OF A RESEARCH INSTRUMENT	95
3.4.1 Validity of the research design	95
3.4.2 Reliability	96
3.5 POPULATION AND SAMPLE SELECTION.....	97
3.5.1 Description of the population.....	98
3.5.2 Method of sampling	99
3.5.2 Sample size.....	99
3.5.3 Questionnaire distribution.....	100
3.5.4 Individual interview procedure	100
3.5.5 Covering letter.....	100
3.5.6 Procedure.....	101
3.5.7 Feedback on the questionnaire from the participants.....	101

3.6 DESIGNING THE QUESTIONNAIRE AS A MEASURING INSTRUMENT	102
3.6.1 The first draft of the questionnaire.....	103
3.6.2 Second draft of the questionnaire.....	104
3.6.3 Statistical techniques.....	105
3.7 CONCLUSION	105
CHAPTER FOUR ANALYSES AND INTERPRETATION	106
4.1 INTRODUCTION.....	106
4.2 SECTION A: DEMOGRAPHIC INFORMATION OF THE RESPONDENTS.....	106
4.3 SECTION B: TECHNOLOGY INTEGRATION INTO LEARNING.....	113
4.4 SECTION C: TECHNOLOGY INTEGRATION FOR EDUCATORS' PROFESSIONAL DEVELOPMENT	119
4.5 SECTION D: EQUITABLE ACCESSIBILITY OF TECHNOLOGY TO LEARNERS	125
4.6 SECTION E: AVAILABILITY OF TECHNOLOGY RESOURCES NECESSARY TO IMPLEMENT TECHNOLOGY	130
4.7 QUALITATIVE RESEARCH.....	133
4.7.1 Individual interviews with educator participants.....	133
4.8 CONCLUSION	150
CHAPTER FIVE SUMMARIES, RECOMMENDATIONS AND CONCLUSION	151
5.1 INTRODUCTION.....	151

5.2 SUMMARIES OF BOTH LITERATURE REVIEW AND EMPIRICAL RESEARCH.....	151
5.2.1 Findings from the literature study	151
5.3 RECOMMENDATIONS	156
5.3.1 Recommendations for further research	156
5.3.2 Recommendations for practical implementation of findings	158
5.3.2.1 Recommendation 1: Schools should employ educators who have been academically and professionally educated and trained in computer technology (see research aim 5).....	158
5.3.2.2 Recommendation 2: School governing bodies and school management teams should strategically budget for computers for every learner in their school (see paragraph 1.1 and research aim 4).....	159
5.3.2.3 Recommendation 3: School Governing Bodies and School Management Teams should be skilled on computer technology strategic management (see research aim 3)	160
5.3.2.4 Recommendation 4: Schools should work with families and communities (see research aim 2).....	161
5.4 CONCLUSION	161
REFERENCES.....	162
ADDENDUM 1 QUESTIONNAIRE FOR EDUCATORS, COMPUTER MANAGERS AND PRINCIPALS	190

LIST OF TABLES

Table 3.1:	Feedback from the population group.....	100
Table 3.2:	Teaching designations	101
Table 3.3:	Location of schools	102

LIST OF FIGURES

Figure 4.1:	Type of school.....	107
Figure 4.2:	Location of schools	107
Figure 4.3:	Enrolment	108
Figure 4.4:	Teaching designation	109
Figure 4.5:	Level of education	110
Figure 4.6:	Number of computers.....	111
Figure 4.7:	Grades that use computers.....	112
Figure 4.8:	Number of computer managers.....	113
Figure 4.9:	Infusion of technology	114
Figure 4.10:	Professional development and technological support.	119
Figure 4.11:	Technology and equity	126
Figure 4.12:	Technology and resources	131

CHAPTER ONE

ORIENTATION

1.1 INTRODUCTION

Despite the promises and predictions made by educational researchers in the early 1980s, computers have not revolutionized education overnight, and few schools have invested whole-heartedly in computer technology (Honey, Culp & Spielvogel, 1999:21). Instead, in an effort to provide computer access to all learners at an affordable cost, despite the low ratio of computers to learners, and because some critics feel there is a lack of quality software or that technology is too complex, schools have often put computers in a single room where learners use them once a week under a specialty educator's supervision (Pullias, 1997:28; Coutts, Drinkwater & Simpson, 2001:228; Kuh, 2001:11).

Unfortunately, this practice has undermined the most valuable aspect of the computer, that is, its ability to cut across traditional learning areas' boundaries as a practical and useful tool. Nagata (1998:12) and Dresang (1999:24) compare the isolation of computers in laboratories to the body's immune response to a foreign intruder; by removing computers from the classroom and relegating them to an isolated laboratory, schools have effectively minimized the potential impact computers can have on learners' learning by turning the technology into a separate, unrelated learning area called "computer literacy." In this laboratory approach, Hope (1997:25) further argues, learners have access to about 1/50th of a computer in school, far from the critical level needed for this technology to have a major impact on educational practices or learning experiences of learners. The fatal flaw in taking computers out of the classroom, according to Taylor (2001:4), is that any information learned about the computers today will be obsolete by tomorrow. Only when computers are integrated into the curriculum as a vital element for instruction and are applied to real problems for a real purpose will learners gain the most valuable computer skill, that is, the ability to use computers as natural tools for learning (Bates, 2000:11).

From the foregoing paragraphs, it is clear that nowadays, more than ever before, computer proficiency needs to become a top priority among educators, learners and parents. Just as literacy has received the national government attention through the Adult Basic Education and Training Programmes, computer proficiency or computer literacy needs to be addressed with similar high level and grassroots efforts. In fact, the two campaigns share many common features and, in the end, achieve many of the same goals. Brantmeier (2004:279) argues that computer literacy and proficiency, which is a familiarity with the use and value that computers, software and related technologies can bring to human everyday lives, can provide individuals of all ages with new opportunities and open new worlds to them. Just as learning to read prepares people to work and live in the "real world," learning to use a computer as a tool plays a similar role. Computers and software can also play a major role in improving the educational skills of learners and in preparing them for the next century. With computers, software and people working together, the possibilities of human resources' development are infinite (Zehr, 1997:24; Simpson & Payne, 2002 12; Roach, 1999:92; Eurydice, 2001:32).

According to Valdez, McNabb, Foertsch, Anderson, Hawkes and Raack (2000:14), a number of national studies have been commissioned in the United States of America in the past years to address the issues surrounding computer literacy. The goal of these studies was to gain a clear idea of just how successful communities have been to date in integrating technology into schools and helping learners leverage their capabilities to the fullest. In the much publicized 1983 study, *A Nation at Risk*, computer literacy joined the familiar "3Rs" that is, reading, writing and arithmetic, as one of the fundamental skills learners need to master (Coley, Cradler & Engel, 1997:23). Another study called *Power On!* was commissioned again by the United States of American Congress and released by the Office of Technology Assessment. *Power On!* provides insight into the effective integration of computer technology tools into the classroom as a catalyst for improved learning. Both of these government studies reflect a growing American concern about the progress made in providing learners with the most up-to-

date computer literacy skills (Hoven, 1999:35; Conroy, Brazier & Clarke, 1999:10).

Of equal importance, most computer literacy studies, according to Tiene and Luft (2001:23), address how unprepared today's learners are to compete in today's technology age. Future Forecasting of Menlo Park, California, predicts that by the year 2010 virtually every job in America will require some use of computer technology. This makes it imperative for learners to become more familiar with technology. Devit and Palmer (1999:136) maintain that computers represent a classroom and home learning tool for today, as well as a strategic business tool for tomorrow. It is for this reason that learners, educators and parents should be computer literate (Hope, 1997:30). In addition to technology being an important element for maintaining and strengthening the individual learning skills of learners, technology can also play a role in addressing key national concerns. For example, effective use of technology as a classroom-learning tool can help alleviate critical problems including the rising number of high school dropouts and the growing rate of illiteracy (Chapelle, 1998:26; Kramsch, 2000:13). Because learning with the assistance of a computer is very individualized (and often more fun), learners tend to be more willing to run through routine drills and comprehension exercises. As a result, educators are finding that learners are more eager to sit down and concentrate on lessons using a computer than ones using more traditional workbook and textbook materials (Frose-German & Moll, 1998:45).

Salaberry (2000:28) indicates that seeking ways to alleviate escalating illiteracy and dropout rates among learners has become a key agenda item for a number of politicians and academicians in the whole world and should continue to remain top-of-mind until solutions are identified and implemented. Literacy, according to Bush (1997:29), is a concern that cannot be solved simply by pouring more money into teaching and learning programmes, although additional funds earmarked for literacy programmes are necessary. While computer technology alone cannot solve these national problems, it can play a powerful and measurable role in helping to raise both the quality of the country's education and the learning skills of learners (Valdez *et al.*, 2000:11).

At the same time, computers have been found to help bolster a learner's self-esteem and self-confidence (Todd, 2000:63). A 1989 Business Week-commissioned study on education in America cites low self-esteem and a feeling of not being accepted by their peers as the number one reason for high school learners dropping out of school before completing grade twelve (Conole, 1999:21). The following facts about how learners are doing at school as listed by Large and Beheshiti (2002:71) are staggering:

- a major percentage of learner population does not read or even speak English, which is the main language of business in South Africa today. According to Nation's Business, more than 40 million adults or 30 per cent of the American adult population cannot read, write or reason well enough to compete in today's economy and the number of functional illiterates is growing each year by an estimated 2.3 million;
- in a survey of youth skill levels conducted by the National Assessment of Education Progress (NAEP), American 13 year olds were found to have the lowest Mathematics and Physical Science scores of the six industrial countries surveyed (Loertscher & Woolls, 2001:42);
- it will take fifty per cent improvement by the year 2010 for the United States to match the Japanese and Europeans in functional literacy, general science and worker training, according to Business Week reports (Hirsh, 1999:65); and
- high school dropout rates in the United States are climbing at exponential rates, and have reached as high as 700,000 in one year. In some inner city areas, as many as 30 per cent of American youth drop out before completing high school (Bailey, 2004:4);

Twigg (2001:22) argues that if technology is to contribute to the solution of solving the foregoing problems, schools need to increase the number of computers available in schools. But, that is only the start. An important element of the equation is to forge partnerships among government, businesses, educators, parents and learners in an effort to use computers

more effectively in education and community centres. As partners, communities and governmental agencies such as the Departments of Education, Technology and Communications need to concentrate on improving the way technology is used in the classroom and in homes (Anderson, 2003:5). This move, according to Simpson and Payne (2002:32) will help promote improved learning for learners, and at the same time, make computers more accessible to all learners and adolescents of school-going ages, from rural and school learners to those learning in urban schools.

Computers offer learners highly individualized learning experiences. In addition, according to findings outlined in *Power On!*, these individual computer experiences have proved to be more comprehensive and motivating than traditional group classroom exercises (New, 1999:83; Pauw, 2002:39). The study notes that elementary learners who received brief daily computer-aided teaching lessons as a supplement to teaching showed gains equivalent to between one to eight months of teaching over their peers who received traditional teaching only (Martinez-Lage, 1997:34). Increases in learner attendance, motivation and attention span have also been reported. Brandl (2002:27) points out that computers can also be very accommodating, for example, they can reach learners at different study levels, any time of the day or night. Additionally, the sense of independence and accomplishment a computer offers helps learners fuel their self-confidence. Relying on a computer as a tool may be one of the most effective ways to build both a learner's learning skills and self-esteem (Richards, 2000:43).

As learners enter the workforce in the coming decades, they will undoubtedly discover that to continue to be effective in their jobs, they need to keep pace with the onslaught of new information. They will need to continue to learn and to take advantage of new technologies that allow them to learn and work more efficiently and productively (Follansbee, 1997:15). It is for this reason that schools should make every effort now to introduce learners to technology (which includes the use of computers) as it can be used as a learning, creativity and productivity tool for everyone (Dunkel, 1999:13).

The South African Gauteng Provincial Government through its Department of Education has started a Gauteng-Online Programme whose main aim is to build a Province-wide schools' computer network, and thereby:

- contribute towards building the human resources capacity of that Province and the country through the provision of quality education;
- contribute towards stimulating positive economic activity in the country through the creation of a strong local IT industry that has a capacity for IT development & innovation;
- enhance the efficacy of government for improved service delivery and a better life for all;
- position the Province at the cutting edge of change through technological innovation; and
- bridge the digital divide (Ankiewicz, Swardt & Stark, 2000:32).

The Gauteng-Online Programme proposes that each public school in that province will be issued with a 25-workstation computer laboratory, with Internet and e-Mail, to be used for curriculum delivery. Such a proposition is in line with the goal of the Government's White Paper on e-Education (2003) which is: "Every South African learner in the GET and FET bands will be ICT capable (that is, use ICTs confidently and creatively to help develop the skills and knowledge they need to achieve personal goals and to be full participants in the global community) by 2013" (Ankiewicz & De Swardt, 2002:21).

1.2 STATEMENT OF THE PROBLEM

From both the international and national literature reviews' findings it is apparent that the integration of technology in the teaching and learning processes is a necessity if learners' latent learning potentialities are to be fully unlocked and well developed for the demands of the technologically oriented twenty-first century. In fact, all schools need to have computers for each learner if South Africa is to succeed in developing self-regulated learners who have the capacity to discover knowledge on their own through individualized learning on the computers (Conradie & Jacobs, 2003:30). All educators need

to be proficient in teaching through computers. This means that computers with the necessary learning software can be an effective tool which educators can use to:

- develop learners' research skills;
- help learners discover new knowledge through surfing the internet;
- help learners develop self-regulated learning skills through working individually on their computers; and so on (Cronje, 2001b:28).

The latter paragraph highlights the need for all schools, which is not yet a reality, in South Africa to be equipped with computers for each learner in the classroom in order to enable him/her to be technologically competent and to be ready to discover new knowledge through self-regulated manipulation of the computer. The e-mail and the internet can be an effective tool for learners and educators to connect with schools, learners and educators all over the world for knowledge sharing, including cultural exchange (Jakovljevic, 2002:45).

The foregoing findings from the literature and this researcher's assertion in the latter paragraph have brought the following questions to her mind regarding the integration of technology in the teaching and learning settings, especially in schools which belong to the Gauteng Department of Education in the Vaal Triangle area:

- What is the nature of technology integration into the teaching and learning practice?
- How have schools integrated computer technologies into learning?
- How have schools integrated computer technologies for professional development of educators?
- Is there an equitable accessibility of computer technology to learners in schools?

- Are necessary resources available to implement technology in schools?
- What can be done to help schools integrate technology into their teaching and learning curricula?

These questions form the basis and core of the research problem of this study and were used to formulate the aims of this research (see section 1.2 below).

1.3 AIMS OF THIS RESEARCH

The aims of this research were to:

- investigate the nature of technology integration into the teaching and learning practice;
- investigate ways in which schools have integrated technology into learning;
- investigate ways in which schools have integrated technology for professional development of educators;
- investigate if there is an equitable accessibility of technology to learners in schools;
- investigate if necessary resources are available to implement technology in schools; and
- make recommendations for schools to integrate technology into their teaching and learning curricula.

To achieve these objectives, this research uses a literature review in order to explore both the national and international literature findings on the scholastic work of researchers on the integration of information technology in teaching and learning settings, and empirical research to find out how schools in South Africa, with particular reference to schools in the Vaal Triangle, have made efforts to integrate information technology in their curricula (see 1.3 below).

1.4 METHODS OF INVESTIGATION

This research consists of a literature and an empirical research.

1.4.1 Literature study

International and national educational journal articles, books, papers presented at professional conferences, dissertations and theses written by graduate scholars and reports compiled by school researchers, university researchers and government agencies providing information on research in the integration of information technology in teaching and learning settings will serve as both primary and secondary sources.

Journal articles, papers presented at professional conferences, dissertations and theses will form primary sources while books will form secondary sources.

To achieve this, all the available data bases (both national and international) will be consulted during the study for example, the NEXUS, SABINET –On-line, the EBSCOHost web and various other web-based sources as well as a DIALOG search etc. will be conducted to gather recent information (2000-2007) studies on the subject. The following key words will be used in the search – technology, integration, school technology, information computer resilience, computer managed instruction, computer based education, computer assisted instruction.

1.4.2 Empirical research

In addition to the literature study mentioned in section 1.3.1 above, empirical data were collected by means of a self-developed questionnaire and individual interviews.

1.4.2.1 Sample of this research

The sample of this research was reached as follows:

- a total of 370 randomly selected sample which consisted of school principals, educators on post level one and computer managers (in the South African context computer managers are those educators that are

responsible for the computer laboratories at schools, their responsibilities include monitoring the activities in the lab, assist educators and report burglaries and faulty computers to GOL) from 18 public schools (n=370) was used for quantitative empirical research; and

- a total of 10 purposefully selected sample which consisted of either a school principal, an educator on post level one or a computer manager (n=10) was used for qualitative empirical research. The qualitative empirical research was in the form of individual interviews.

The total sample of this research is (N=380). The sample for quantitative research was randomly selected from public schools and tertiary institutions from the D7 and D8 districts in the Vaal Triangle. The sample for qualitative research was purposefully selected from ten primary schools in D7 and D8 districts. According to Patton (2001:112), the purposive sampling method is an appropriate way of selecting rich cases for study in-depth. Leedy and Ormrod (2005:145) state that in purposive sampling individual or objects that will yield the most information about the topic under investigation are selected.

For the purpose of this study a two-phased model suggested by Creswell (2003:165) was used. The first phase was quantitative where questionnaires were distributed to 370 principals, educators on post level one and computer managers who formed the randomly selected sample of this research. The second phase was qualitative where either a principal, an educator on post level one or a computer manager was purposefully selected from 10 schools which had been supplied with computers by the Department of Education in Gauteng, with a view to interviewing them on questions relating to the aims of this study and to answer the questions which were posed for this research in section 1.1 above.

1.4.2.2 Target population

The target population included primary, secondary and tertiary institutions in township, farm and urban areas in the Gauteng Province.

1.4.2.3 Accessible population

There is a large number of primary and secondary school educators serving various farms, rural and urban communities in the Gauteng Province, which would have taken a long period to cover and would have had unaffordable financial implications for the researcher. The target population was, therefore, limited to the Vaal Triangle's farm, township and suburban public and tertiary school educators.

A sample of (N = 380) principals, educators and computer managers from 18 public schools in the Vaal Triangle area of Gauteng Province was drawn.

1.5 ANALYSIS OF EMPIRICAL DATA

In order to investigate the nature of technology integration into the teaching and learning practice; ways in which schools have integrated technology into learning; ways in which schools have integrated technology for professional development of educators; if there is an equitable accessibility of technology to learners in schools; if necessary resources are available to implement technology in schools; and make recommendations for schools to integrate technology into their teaching and learning curricula, the data obtained by means of questionnaires from a randomly selected sample of (N = 380) principals, educators and computer managers from 18 public schools in the Vaal Triangle area of Gauteng Province, through quantitative empirical research, were analysed with the aid of the SPSS - X computer programme by the North-West University's (Vaal Triangle) Information and Technology Services Department. The data obtained by means of individual interviews was analysed and interpreted by means of themes.

1.6 CHAPTER DIVISION

CHAPTER1: Introduction and Statement of the Problem.

CHAPTER 2: Literature Review

CHAPTER 3: Empirical Design.

CHAPTER 4: Empirical Data Analysis and Interpretation of Results.

CHAPTER 5: Summaries, Recommendations and Conclusions.

1.7 CONCLUSION

This chapter provided an orientation to the research. The next chapter provides, by means of the findings from the literature review, what both national and international researchers have propounded on the integration of information technology in teaching and learning settings.

CHAPTER TWO

LITERATURE REVIEW

2

2.1 INTRODUCTION

Section 1.1 of Chapter 1 revealed that, for both learners and educators, computer technology represents access to new worlds. Computers provide information - that is, both text, audio and graphic-based - about new areas of learning, new places, new shapes, new worlds (Ayres, 2005:241). Lamy and Goodfellow (1999:29) maintain that they stimulate new ways of thinking and analyzing problems. With computers, people are free to "play" with the information and look at facts and ideas in different ways. While computers shouldn't eliminate the need for learners to memorise their multiplication tables, they can make memorising the facts a lot more fun. Hegelheimer and Tower (2004:185) further acknowledge that computers add a new, third dimension to data. It is almost as if personal computer software adds some personality to routine facts. And for learners, that added zest can be the key to more productive and focused study sessions.

Increased access to information is another benefit that can be realised when computers are integrated into learners' learning experiences. Just as more immediate access to information via personal computers has been instrumental in providing Fortune 500 and small companies with business advantages over their competitors, computers offer advantages for learners (Osuna & Meskill, 1998:17; Warschuer, 1997:470). Today, computer users young and old can access information through hundreds of online information and database services (Barcelo, 2004:275). And with the increased storage capabilities offered by CD-ROM technology, the computer is able to take on even more critical roles as "information grabbers" and organizers for individuals, schools and businesses. It is clear that learners who become computer literate today will be better prepared to take on future academic and professional challenges with the aid of computers and software (Kafai & Bates, 1997:103).

2.2 CLARIFICATION OF CONCEPTS

The following concepts which are used in this chapter and throughout this research need clarification:

2.2.1 Computer Based Education

This concept refers to the use of computer technology to provide direction instruction or management of instruction to the learner. Excluded from this definition is the use of the computer as a tool, such as programming, problem-solving, running application programmes, developing computer architecture and administrative applications outside the domain of instructional and learner management (Beld, 2004:43). The three major components of Computer Based Education are:

2.2.1.1 Computer Assisted Instruction (CAI)

In CAI the computer provides a direct instructional tool for a student or small group of students with the goal of having the student learn a defined body of content or skills or instructional objectives (Van der Westhizen, 2002:12). CAI employs several different approaches to instruction: the most often used are tutorial, review and practice, simulation, and more recently navigation (Ayres, 2005:242).

2.2.1.2 Computer Managed Instruction (CMI)

In this other major category of Computer Based Education, the computer assesses each individual student on knowledge of a specific body of content or skills or instructional objectives and informs the student of his level of knowledge (diagnostic) (Doczi, 2000:46). The computer also communicates to the learner what study assignments to be undertaken to remove the areas of weakness identified in the diagnosis (prescriptive). CMI is thus referred to as diagnostic and prescriptive testing (Hauck, Willingham & Youngs, 1999:269).

2.2.1.2 Educational Technology

Educational Technology, also known variously as e-learning, instructional technology and learning technology, refers to the use of technology to support

the learning process. Although the term can refer to all kinds of analogue technologies, for example photographs, film, video, audio recordings etc, it is usually used to talk specifically about digital computer technology (Vadero, 1997:13).

Although technology is widely used in the administration and management of education (eg student records, marketing, procurement, finance etc etc) and in research, educational technology is only concerned with technology as it impacts upon the learning process, for example in delivering learning materials, facilitating communication and providing assessment and feedback (Bello, 2003:29). In this way, technology benefits both traditional (ie face-to-face) and open and distance learning models. And perhaps it makes it easier to combine different educational models to provide a blended learning experience tailored to the individual's needs (Salmon, 2000:14).

2.2.1.3 Information and communication technology

Information and Communication Technology (ICT) represents the convergence of information technology and communication technology. ICT is the combination of networks, hardware and software as well as the means of communication, collaboration and engagement that enable the processing, management and exchange of data, information and knowledge (Department of Education, 2003:16).

According to Mawson (2003:117), communication technology (CT) is a term used to describe telecommunications equipment through which information can be sought, sent and accessed – for example, phones, faxes, modems and computers.

Information and communications technologies (ICTs) represent the convergence of information technology and communication technology. (ICTs) are the combination of networks, hardware and software as well as the means of communication, collaboration and engagement that enable the processing, management and exchange of data, information and knowledge (Condie, Simpson, Payne & Gray, 2002:54).

Digital literacy refers to the ability to appreciate the potential of ICTs to support innovation in industrial, business, learning and creative processes. Learners need to have the confidence, skills and discrimination to adopt ICTs in appropriate ways. Digital literacy is seen as “life skill” in the same category as literacy and numeracy (Somekh, 2000:19).

Information literacy is the ability to locate, evaluate, manipulate, manage and communicate information from different sources. As learners become increasingly information – literate, they develop skills in discrimination, interpretation and critical analysis (Todd, 2000:61). ICTs offer opportunities for higher – order thinking and creativity in processing, constructing and conveying knowledge (Callison, 2003:89). e - Learning is flexible learning using ICT resources, tools and applications, focusing on:

- accessing information;
- interaction among educators, learners, and the online environment; and
- collaboration (Simpson & Payne, 2002:103; Bates, 2000:35).

2.2.2 Information Technology

Information Technology (IT), as defined by the Information Technology Association of America (ITAA) is the study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware (Johnson, 1997:161). In short, IT deals with the use of electronic computers and computer software to convert, store, protect, process, transmit and retrieve information, securely (Kearsley, 1998:15).

It is a term used to describe the items of equipment (hardware) and computer programmes (software) that allow us to access, retrieve, store, organise, manipulate and present information by electronic means (Department of Education, 2003:16; CEDEFOP, 2001:63). Personal computers, scanners and digital cameras fit into the hardware category; database programmes and multimedia programme fit into the software category (Martin & Rader, 2002:12).

In this definition, the term "information" can usually be replaced by "data" without loss of meaning. Recently it has become popular to broaden the term to explicitly include the field of electronic communication so that people tend to use the abbreviation ICT (Information and Communication Technology) (Met, 2004:11).

2.2.3 Instructional technology

Although *Webster's New Collegiate Dictionary* takes a sociological perspective in its definition of technology as "...the totality of the means employed to provide objects necessary for human sustenance and comfort" and "a technical method of achieving a practical purpose," the prevailing public definition based on current usage is "technology equals machinery." This limited focus on machinery at the expense of process ignores the true sense of technology as "the systematic application of scientific and other organized knowledge to practical tasks" and thus as a problem-solving process using human and other resources to seek solutions to human problems (Hamilton, Furnace, Duguid, Helms & Simpson, 1999:298).

Within this broader sociological framework of technology, the terms "e-Educational" and "instructional technology" come to the fore. Often used interchangeably, both share a common interest in the processes of human learning and teaching, with some variations in definitions and levels of complexity, depending upon one's personal viewpoint (Jakovljevic, Ankwicz, De Swart & Gross, 2003:263). For convenience and consistency, the researcher will most likely blend elements of the two terms, but use "instructional technology" as primary focus in this research.

Instructional technology encompasses the broader processes of teaching and learning, the prevailing public perspective which incorporates instructional technology as a synonym for computer technology. In other words, as noted above, technology means computers in the minds of many (Macome, 2002:43). Fry, Ketteridge and Marshall (1999:79) maintain that myopic view has generated some of the problems related to integration, in particular, the

focus on access to hardware at the expense of effective pedagogy, as if one particular medium is the panacea for the challenges facing education.

2.2.4 Computer-Assisted Learning

Computer assisted learning is an encompassing term which generally refers to teacher centred instruction with three major uses of computers in education and training.

- **Computer Literacy**

In a computer literacy a scope and sequence of curriculum goals is developed within a school district that specifies what is to be learnt about the use of a computer and about its role in society. It often examines the history of computing and computer awareness and functional use, as well as the broader role of the computer as it relates to societal issues such as computer access, gender relationships, software copyright, rights of privacy, data security and information ownership (Van der Westhuizen, 2002:12).

- **Computer-Assisted Instruction**

The first is called computer-assisted instruction and can be described as learning through computers. In CAI, instructional sequences and questions must first be preprogrammed and then students use the preprogrammed instructional material in an interactive fashion (Van der Westhuizen, 2002:12). Examples of typical CAI sequences are drill and practice, gaming, simulation, Socratic questioning, testing and tutorial instruction. In CAI emphasis is placed upon having students learn new concepts or in reinforcing previously learned concepts. Unfortunately, because it takes many hours to develop even one hour of CAI, the cost of producing CAI programs can be expensive (Ayres, 2005:243).

Instructional or CAI software teaches specific skills and knowledge, often narrowed to a specific content area and grade range. It is in contrast to Tool software that can be used in general to help students through problem processing at any grade level and in any content area, such as: word processors, concept processors (outliners, programming language), etc.

Finding software that fits just one of these categories is often difficult because one or more or all forms are commonly integrated into a single instructional software program (Kafai & Bates, 1997:105).

- **Computer-Managed Instruction**

The second major use of CAL is for computer-managed instruction. In this instructional mode, the computer mainly manages a student's instructional activities (Van der Westhuizen, 2002:12). This is accomplished by allocating or scheduling learning materials and physical resources for each student; providing the student with access to test questions; grading examinations or assignments; providing diagnoses of learning performance based upon test performance scores; prescribing different instructional activities according to the student's performance and/or rate of progress; and record keeping (Gee, 2004:17). CAI sequences can be included in CMI-based courses, but this has usually not been done due to the high cost associated with producing or acquiring CAI materials. Students using CMI generally only need occasional access to a computer since it is possible that most of the learning materials are available offline (Gee, 2003:23). The instructional sequences in CMI are accomplished through a variety of traditional non computer techniques such as regular classroom instruction, self-instructional materials, laboratory work, seminars and workshops. Consequently more CMI students are accommodated per computer than is the case with CAI where constant access to a computer is required by each user. Due to the fact that provision of instruction via CMI is often much less expensive than through CAI, CMI is often the instructional model of choice when funds are scarce (Romaniuk, 2007:24).

2.2.5 e-Education

In the South African context, the concept of e-Education revolves around the use ICTs to accelerate this achievement of national education goals, e-Education is about connecting learners and educators to each other and to professional support services, and providing platforms for learning e-education will connect learners and educators to better information, ideas and

one another via effective combination of pedagogy and technology in support of educational reform. It supports larger systematic pedagogical, curricular and assessment reforms that will facilitate improved education and improved use of educational resources such as ICTs (Department of Education, 2003:15).

The challenge according to the Department of Education (2003:15), is to transcend the mere exchange information and to transform e-Education into a range of learning activities that meet educational objectives (Cronje, 2001a:27). e-Education is more than developing computer literacy and the skills necessary to operate various typed of information and communication technologies. It is the ability to:

- apply ICTs skills to access (get information), analyse (examine the nature of information gathered), evaluate (estimate the value of the information), integrate (combine information), present (show or describe something in a particular point of view) and communicate information (pass information to other people);
- create knowledge and new technology by adapting, applying, designing, inventing and authoring information; and
- function in a knowledge society by using appropriate technology and mastering communication and collaboration skills (Department of Education, 2003:15; Disraeli, 2001:62).

e-Education views ICTs as a resource for recognising schooling, and a tool to assist whole-school development (Conradie & Jacobs, 2003:31). It includes ICTs as:

- a tool for management;
- an administration tool to increase productivity;
- a resource for curriculum integration;
- a communication tool;
- a collaborative tool for educators and learners; and
- a learning environment that advances productivity, creativity, communication, collaboration and engagement (Brantmeier, 2004:281).

2.2.6 e-Learning Tools

E-learning tools come in three main flavors; a content/course or learning management system (CMS/LMS), synchronous collaboration applications, and all other computer tools/applications including asynchronous collaboration applications. Game play or game simulation software is rapidly becoming the fourth type of readily accepted e-learning tool (Romaniuk, 2007:31).

CMS/LMS include applications like Blackboard, Moodle, WebCT, Desire2Learn, etc, that create a shell in which to organize the content of the instruction. These CMS/LMS applications can be quite robust by offering the ability to include self-contained surveys or assessments, to track individual learner use of the course site and all of the components thereof, and to provide forums for asynchronous and synchronous learner-to-learner and learner-to-instructor communication (Van der Westhuizen, 2002:14).

Synchronous collaboration tools include applications like Wimba, CentraOne, HorizonLive, Elluminate, NetMeeting, etc. These applications allow real-time communication via voice and video, as well as, a virtual whiteboard, textchat and possibly application sharing capabilities (Brennan & Rowe, 2004:17).

Email, instant messaging, blogs, podcasts, surfing the Web, CDs, DVDs, mp3s and online and offline computer applications can be used to deliver e-learning. Just about any computer application can be an e-learning delivery or collaboration tool (Pauw, 2002:40).

Games and game play is the up and coming fourth type of e-learning delivery tool. From the use of Solitaire in Business Education classes to assess mouse skills to SIMS in middle school Social Studies to teach types of government, gaming is making its way into education (Brantmeier, 2003:51).

2.3 TECHNOLOGY INTEGRATION

From section 2.2.1 it became apparent that computer technology is merely *one* possibility in the selection of teaching and learning media and the delivery mode, that is, part of the teaching and learning design process, not the end but merely one of several means to the end. At the same time integration of

technology in the classroom does not just mean placement of hardware in classrooms. In this regard, Carr, Reznick and Brown (1999:430) ask if computers are merely add-on activities or fancy work sheets, where is the value? Williams and Coles (2003:64) posit that technologies must:

- be educationally sound;
- go beyond information retrieval to problem solving;
- allow new teaching and learning experiences not possible without them;
- promote deep processing of ideas;
- increase learner interaction with learning areas;
- promote school and learner enthusiasm for teaching and learning; and
- free up time for quality classroom interaction - in sum, improve the teaching and learning process.

Salmon (2000:12) argues that the educational technology that can make the biggest difference to schools and learners is not the hardware, but the process of designing effective teaching and learning processes and practices, which incorporate computer technology and other media appropriately.

From the latter paragraph it is apparent that integrating technology is not about technology per se, it is primarily about content and effective teaching and learning processes and practices. Technology involves the tools (in the case of this research, tools refer to computers) with which educators deliver content and implement teaching and learning practices in better ways. Integration is defined not by the amount or type of technology used, but by how and why it is used (Ropohl, 1997:65).

Successful technology adoption/integration requires concerted focus on the mission of improving education for all learners. It grows from the mission. As an add-on or fad, it soon withers. It must be seen as an on-going innovative process designed to meet teaching and learning needs (Viadero, 1997:12).

Honey (2001:49) captured a significant insight when he stated that "it is not technology *per se* that has resulted in improved learner outcomes, but rather how the technology was used and integrated into instructional processes." While noting increased learner proficiency in using technology for learning rather than as technology for its own sake, he also attributed such achievements to educator planning and expertise, recognizing that true success must be measured in terms of improvement in teaching and learning, not merely in the placement of computers in classrooms. Brantmeier (2003:50), who describes herself as a technophile, emphasized the prudent, ethical use of technology and warned educators "to resist the seductive force of technology to replace rather than enhance." She stressed that very human elements such as intuition, judgment, imagination, and creativity cannot be replaced and that technology may fail if it is viewed as change for the sake of change (Casey, 1997:48).

Smith (1999:25) reinforced this perspective by stressing that "unless other simultaneous innovations occur in education, curriculum, assessment, and school organization, the time and effort expended on instructional technology produce few improvements in educational outcomes - a result that reinforces many educators' cynicism about fads based on magical machines.

Lan (2000:21) in a review of educational transformation, reminds educators that, since technology is ubiquitous, the issue is not whether, but how educators contend with it. He stresses that as technology becomes more powerful, good educators become more indispensable. Technology generates a glut of information, but it has no particular educational wisdom, especially regarding new break-throughs in cognitive science about how learners must construct their own meaning for deep understanding to occur (Martin & Rader, 2002:23). This means that educators must become experts in educational design. It also means that educators must use the powers of technology, both in the classroom and in sharing with other educators what they are learning (Sachs, 2000:52).

Initially, the real power of technology probably lies in the way its use causes educators to develop different perspectives through re-thinking teaching and

learning (Ascough & Richard, 2002:17; Cotton, 1997:33). Teaching with technology causes educators to confront their established beliefs about instruction and their traditional roles as classroom educators (Spotts, 1999:59).

From the foregoing paragraphs it can be deduced that the principles of integration are, *inter alia*, the following:

- instructional technology does, indeed, hold a remarkable promise for changing the quality of teaching and learning in schools. It is the catalyst for transformation - but this does not mean that schools merely need more computers in their classrooms (Crabtree, Nathan & Reeves, 2002:19).
- Technology also involves *process*. Too often schools' efforts to improve education have resulted in their unrealistic isolation of technological processes (Maddux, Cummings & Torre-Rivera, 1999:43).
- Technologies are valuable resources, but only when used in a systematic process for developing human competence (Norris, Smolka & Soloway, 2000:45).
- Integration (from the Latin *integrare*, to make whole) includes a sense of completeness or wholeness and incorporates the need to overcome artificial separations by bringing together all essential elements in the teaching and learning process - including technology (as one of the elements, not the sole element) (Earle, 1998:8; Jakovljevic, 2002:31).
- Change starts with the individual educator, who, upon catching the vision, is willing to take risks, to experience Christopherian confrontations or encounters in rethinking teaching and learning, and to model for and be a mentor to peers. Just as Christopher Columbus confronted the intuitive impression that the earth is flat with the conception of a spherical earth, so educators must grasp the opportunity to reconsider established practices and rethink teaching and learning. Conversion to a theory, practice, process, or approach, such as technology integration, is a very personal process (Norum, Grabinger & Duffield, 1999:187; Spotts, 1999:56).

- It involves:
 - preparation of the educator (building relationships of trust, helping educators feel and recognize the power of teaching with technology, personalizing training, and finding out educator needs, interests, and concerns) (Aplevich & Willment, 1998:52);
 - commitment by the educator, *following-up* on that commitment by the support team, and *resolving educator concerns* arising during the change process (Condie *et al.*, 2002:92); and
 - educators move through at least three levels, that is, confidence, competence, and creativity (Somekh, 2000:19).
- It is a process of gradualness as educators' progress from learner to adopter to leader. At first they utilize existing practices, then adapt to their own needs, and finally design their own integrated experiences. Such educators "face their own fears and struggles with technology and change by taking the time to reflect on their own role and professional practice in this process of integration" (Eurydice, 2004:12).

It is important to remember that technology is not a subject (Hara & Kling, 2000:22). The focus of integration is on pedagogy - effective practices for teaching and learning. Educators need to be able to make choices about technology integration without becoming technocentric by placing undue emphasis on the technology for its own sake without connections to learning and the curriculum (Mayes, 1998:375). For both pre-service preparation and in-service professional development, this means providing experiences, primarily in:

- instructional design;
- media selection;
- modeling exemplary technology practices;
- clinical activities;

- resource sharing; and
- extensive and sustained training and practice (Met, 2004:11; Phillips, 2000:23).

Valdez *et al.* (2000:54) explain that educators need opportunities to:

- observe models of integrated technology use;
- reflect on and discuss their evolving ideas with mentors and peers; and
- collaborate with others on meaningful projects as they try out their new ideas about teaching and learning with technology.”

Plass (1998:72) further posits that the curriculum must be the vehicle for technology integration. Just as reading is content-free, that is, incorporates all subject areas, so is technology. Educators must weave technology into the fabric of learning, or as West (2003:14) admonished: Fit the computer to the curriculum, not the curriculum to the computer.

Exemplary practices reported in professional journals such as *Educational Technology*, *Tech Trends*, *Technology and Learning*, *Educational Leadership*, and *Learning and Leading with Technology* have showcased individuals, programmes, and schools that have successfully taken on the restraining forces listed above (Casey, 1997:29). Such efforts show people that reducing these forces is the key to overcoming the obstacles and breaking down the barriers to the meaningful integration of technology into teaching and learning (Kearsley, 1998:42). Converting these restraining forces to facilitating factors is essential. Take any of the restraining forces such as time, support, training, leadership, or resistance and one can see that it is much easier to remove the barrier by resolving and reducing concerns than to attempt to use additional force to plow through the barrier, that is to say, the former approach is facilitative and constructive while the latter is divisive and destructive. The solutions are many and varied depending on local conditions (Mooij & Smeets, 2001:265; Beld, 2004:43).

ICTs, when successfully integrated into teaching and learning, can through meaningful engagement and facilitation bring about meaningful interaction of learners with information, ICTs can advance high order thinking skills such comprehension, reasoning, problem-solving and creative thinking and enhance employability (Melville & Goddard,1996:78).

It is further a motivational tool and enhances productivity. Success in the fusion of ICTs into teaching and learning will ensure that all learners will further education and training (FET) institution (Fulton-Calkins, 2003:29).

- Moreover, these learners are likely to utilise e-government processes, not only to acquire and use information, but also to implement public reforms that can enhance transparency in government operations. These learners will use ICTs to enhance integration between citizen, government organisation and public and elected officials (Proenza, 2001:62).
- These learners will invent new ways of using ICTs.
- Education's vision of developing citizens who are critical and active lifelong learners.
- The challenge facing our education and training system is to create a learning culture that keeps pace with these changes, and equips people with the knowledge, skills, ideas and values needed for lifelong learning.
- Our education system must create graduates who use information effectively and keep abreast of technological advances (McNair, 2000:42; Lisle, 2003:130; Perry, 2004:28).

2.4 FORCES OF CHANGE AS THE THEORETICAL FRAMEWORK OF THIS RESEARCH

Taylor's (2001: 4) force field analysis theory illustrates the dynamics at work in the change process. Movement from the present level of performance to a desired level is facilitated by driving or encouraging forces, while at the same time, it is hindered by restraining (or resisting, discouraging) forces. The

present situation usually represents a state of equilibrium or balance between these driving and restraining forces.

Driving forces for technology integration might include the power and potential of new developments, rapid availability, creativity, Internet access, ease of communication, or the promise of impact on learning. Restraining forces might include barriers and constraints such as technical support, educator expertise, time for planning, or educational applications (McCoy, 1999:23). Watson (2002:12) has stressed that when innovators change one part of a system, the system almost always works to change itself back again unless those solutions move from a symptomatic to a fundamental change in the system. For technology to become an integral aspect of classrooms and curricula, the changes in educator and learner behaviours must, of necessity, be fundamental to the system rather than quick fix solutions, which merely focus on the surface symptoms. Devitt and Palmer (1999:139) have referred to this phenomenon as "straightening the deck chairs while the structure of the ship we are traveling on remains the same."

Heath's (2003:40) analogy provides a useful strategy for addressing change through the responses to driving and restraining forces. The question of whether to increase driving or decrease restraining forces is analogous to the question "If I'm driving a car and see the emergency brake is partly on, should I release the brake or put on more gas?" Accelerating may increase the speed, but it may also burn up the engine. Releasing the brake, on the other hand, would allow one to attain high speeds more efficiently.

Hence, focusing on reducing restraining forces would appear to be a more productive use of energy. The following sub-section attempts to identify these forces and consider their nature.

2.4.1 Identification of restraining forces

Despite the general sense that the computer revolution of the last decade has had a major impact in schools, the nature of this impact seems to be limited to access and information retrieval rather than improved teaching methods or re-

vitalized school and classroom structures (Moore, 2000:62). The following constraints and barriers have been acknowledged:

- access to hardware and software as well as funding;
- time for planning, personal exploration, online access, and skill development;
- technical and administrative support and resources;
- training and expertise;
- resistance, passivity, school cultures, and traditions of teaching;
- vision and leadership; and
- support for integration of technologies into instruction and the curriculum (Hope, 1997:29; Loggett & Persichitte, 1998:33; Jacobs & Rodgers, 1999:9; Amos, 1999:126; Lan, 2000:21; Huber & Morreale, 2002:23; Mawson, 2003:117; Osborn, Peterson, Sampson & Reardon, 2003:356; Stoll, Fink & Earl, 2003:47; Lee, 2004:21; Munn, Stead, McLeod & Brown, 2004:433).

Candy and Bruce (2000:34) have grouped these barriers into the following two categories:

- first-order barriers extrinsic to educators such as access, time, support, resources, and training; and
- second-order barriers intrinsic to educators such as attitudes, beliefs, practices, and resistance.

Salaberry (2000:34) further asserts that even if every first-order barrier were removed, educators would not automatically use technology and in fact, rather than being eliminated completely, such barriers will continue to ebb and flow throughout the evolutionary integration process.

2.4.2 Lessons from educational technological past

Computer technology is new to South African township schools. Mercadante (2002:56) warns that focusing exclusively upon the newness of computer technology alone, independent of teaching and learning processes, may cause educators to repeat technological history without reaping the potential benefits of this remarkable technology. Educators may unintentionally succumb to the malady of "data, data everywhere, but not a thought to think." Wang (2004:4) further argues that educators infatuation with the promises and possibilities of technology as hardware at the expense of technology as a process has overshadowed key lessons which the world has learned from prior experiences in the field of educational technology, which teach that:

- there is no one best medium;
- the medium is the means, not the end; and
- the medium is not the message.

McKenzie and Murphy (2000:239) remind us that focusing exclusively on technology as a panacea for improving teaching and learning activities in schools has been somewhat fruitless across decades of technological innovations. According to Callison (2003:16), from lanternslides to language labs, from closed-circuit television to microcomputers, attempts to improve American schools with modern machines have been something less than a resounding success. Beginning with the magic lantern and the stereoscope of 1900, machines in the classroom have generated some promise, a fair amount of controversy and a great deal of hype (Callison, 2003:16).

During these 90-plus years, however, the basic acts of classroom teaching have changed very little despite sporadic efforts at research and reform - with and without machines (Williams, Wilson, Richardson, Tuson & Coles, 1998:34).

Fidel, Davies, Douglass, Holder, Hopkins, Kushner, Miyagishima and Toney (1999:24) have added their own historical insights to educators' current

dilemma in order to remind them of yet another lesson from the past, that is, the power of the educator in technology integration. Inventions from Olivier's (1999:87) phonograph and the blackboard to audio-tape and instructional television have all been pressed into service to make up for the perceived deficiencies of the ordinary classroom educator. But efforts to replace educators with technology have uniformly failed. Inventions intended to take over teaching come and (mostly) go; what happens in classrooms looks pretty much the same (Evenbeck & Kahn, 2001:43). Why? Because technology enthusiasts continue to forget a basic fact: Machines are tools, valuable only when a human intelligence organizes their use in a productive way. In the classroom, that human is the educator, who controls the nature of the environment and what happens there. Good classroom tools extend the educator's power to create a rich learning environment (Muller-Hartmann, 2000:23). If the educator does not know what to make of the tool, or fears it, or misconstrues its uses, it will be used badly or not at all. If the educator perceives the machine as a master, not as a servant, its potential will never be realized (Jegede, 2002:34).

2.5 THE CURRENT STATUS OF CLASSROOM TECHNOLOGY

In the context of this research, classroom technology refers to the infusion of instructional computers in the learning and teaching setting. In such a setting, every learner has, for example, access to the vast network of information on the Internet. As a result of this connection to the internet, learners are always connected to an exciting new world of hot and lively current information and make and develop meaning insight while the teacher shows them how to navigate and reason through the labyrinth of new sources (Eurydice, 2004:34).

A nationwide survey of educators and superintendents commissioned by Scottish Executive (2003a:14) indicated that the computer revolution has had a tremendous impact in the classroom. Surprisingly, however, the emphasis was on learner access to information outside the classroom and improved learner motivation, not on specific academic achievement (Barcello,

2004:275). In fact, fewer than half of the educators used computers for instructional purposes, rather than word-processing, spreadsheets, or graphics for personal productivity only. Differing priorities showed that educators would rather see additional funding used to increase the number of computers in classrooms, while superintendents felt that educator training would best improve computer effectiveness. Taylor (2001:4) and Cole (2000:30) indicate that while reporting strong computer usage by educators actually indicated a lack of integrated use with the curriculum. In many instances, it has been a case of fitting the curriculum to the computer rather than the computer to the curriculum.

A comprehensive look at class technology in a series of articles by Jegede (2002:26), which shared several interesting facts about the state of computer technology in public education, has revealed the following:

- “the dividends that educators can expect from this...unprecedented support for classroom technology...are not yet clear....There is no guarantee that technology improves learner achievement” (Ayres, 2005:244);
- 43% of respondents in a survey felt that the introduction of computers into public classroom was not happening fast enough (Kerr, 2005:1005);
- despite the lack of research evidence, 74% of the public and 93% of educators agreed that computers had indeed improved the quality of education, teaching, and learning (Burns-Glover, 2001:12);
- research on the effects of technology on learner achievement offers mixed results (Young & Figgins, 2002:144);
- placing computers and software in classrooms is not enough. Discovering whether technology “works” is not the point. The real issue is when and under what circumstances. Like any other tool, educators have to come up with a strategy or pedagogy to make it work (Bilal, 2002:70);

- wise use of technology takes adequate training, time, planning, support, and educator ownership (Campbell & Salazar, 2004:5); and
- money spent on school technology is wasted without an equal effort to help educators with its use and integration into the curriculum (Meskil, Mossop, Diangelo & Pasquale, 2002:30).

New technologies have indeed transformed classrooms for learners and educators. According to the Gonzalez-Bueno (1998:60), educators are using technology to create exciting and creative learning environments where learners teach and learn from each other, solve problems, and collaborate on projects that put learning in a real-world context. In a meta-analysis of the value and use of technology in education (Hemard & Cushion, 2003:119), the North Central Regional Laboratory found that technology innovations are increasing the demand for transformation in teaching and learning approaches that, in turn, are having a significant impact on technology use expectations. The report also found a very strong connection between appropriate educator use of technology and increased learner achievement (Bilal, 2000:646).

Mayer and Scorbrough (1997:96) maintain that technology offers opportunities for learner-control, increased motivation, connections to the real world, and data-driven assessments tied to content standards that, when implemented systematically, enhance learner achievement as measured in a variety of ways, including, but not limited to standardized achievement tests.

Working in an appropriately designed technology-rich environment has the potential of producing a variety of positive outcomes according to Waddoups, Wentworth and Earle (2001:12), such as:

- improved patterns of social interaction;
- changes in teaching styles;
- more effective teaching, increased learner and, perhaps, educator motivation; and
- enhanced learner learning.

Achieving this potential, however, is the challenge, and it requires the correct vision of technology and its integration.

2.6 EDUCATORS AND TECHNOLOGY

Conlon and Simpson (2003:137) advocated “unleashing the full potential of technology” by “letting the genie out of the bottle,” as if, by allowing this powerful force to roam into schools, something magical will automatically happen and all educators’ wishes will be granted. Although a plethora of researchers (Chalhoub-Deville, 2001:5; Bilal, 2001:118; Evans & Nation, 2000:102; Kerr, 2005:1008) strongly believe in the great promise that technology holds for both learners and educators, there is also a need to remember that:

- first and foremost, technology is a communication tool. It is not the silver bullet that will solve all of our education problems, but it is certainly a useful tool that enables educators to link various learning communities together in new and different ways (Cole, 2000:29); and
- technology is not about what technology by itself can do, but what educators and learners may be able to accomplish using technological tools.

In labelling technology as the “great siren song of education,” Lehmann, Freedman, Massad and Dintzis (1999:38) argue that educational technology “has become primarily, if ironically, a distraction (on a grand scale) from what matters most, that is, effective learning and good teaching”. By focusing merely on how to use computers, technology training has failed and has caused us to miss the forest for the trees by not addressing how to teach learners more effectively using a variety of technological tools (Agee & Zenelis, 2002:93). They further lamented the lack of technology preparation for educators (too little and too late), stressing the realistic need for extensive and sustained practice over years, not one-day workshops. What educators need to know most is how to teach content more effectively. Because of schools’ quick-fix mind-set in education, they myopically “teach people how to use specific types of technology [rather than] how to solve educational

problems using technology when needed and appropriate“(Cubillos, 1997:44). A survey by Scottish Executive (2003b:16) and the American Association of School Administrators reported that educator training, while readily available, focuses merely on basic computer operation and fails to address helping educators use technology to teach more effectively.

Even though Summers, Rinehart, Simpson and Redlich (1999:330) have expressed the view that a well-trained and effective educator is still preferable to the most advanced technology, and that even excellent hardware and software are to little avail in the absence of appropriate curricula, pedagogy, and assessment, he nevertheless admitted that “immersing oneself in a problem using the latest technology...can make a significant contribution to learner learning.” For him, the most important question is whether such technological prosthetics actually improve classroom performance and lead to deeper understandings and become “helpful handmaidens in the [learning] process” (Salmon, 2000:12).

Web-Based Education Commission (2000:35) has warned educators that new technologies alter:

- the things they think about;
- the things they think with; and
- the arena in which thoughts develop.

Hence, technology has become a serious arena for academic work (Amos, 1999:125). This is the promise and the potential. It is also the challenge. The questions to be addressed are:

- Who is in charge?
- Who is the driving force?” (Hauck *et al.*, 1999:269)

The answer to these two questions should be the educators who use the technology well. It cannot be the technology in and of itself.

A review of research studies and reports compiled in the early years of the past decade demonstrated the value of technology in:

- enhancing learner achievement;
- improving learners' attitudes about themselves and about learning; and
- changing the learning environment (Donham, Bishop, Kuhlthau & Oberg, 2001:67).

However, these authors emphasized that the decisions made by well-trained educators (necessarily) determine the computer's ultimate instructional effectiveness and that the most important determinant of learner attitudes when using technology is the educator (Department of Education, 1999:23).

From the foregoing paragraphs in this section it is clear that educator roles in computer-enriched classrooms can be mentioned as follows:

2.6.1 Instructor

Perlman, McCann and McFadden (1999:38) posit that when the computer is introduced into the classroom, an initial learning period occurs during which the learners need time to become familiar and comfortable with the technology. It is during this period that the educator needs to assume the most active role in instructing learners, guiding them through new software and encouraging their exploration of the material.

2.6.2 Coach

As learners gain experience with computers, the focal role held by the educator gradually diminishes; learners are able to perform tasks independently, and peers begin to take over the role of instructor. The educator then moves into the role of facilitator, providing guidance and support when needed and ensuring appropriate behaviours, while control of the situation remains in the hands of the learner (Met, 2004:16).

2.6.3 Model

Learners will be much more likely to use the computer as a practical, integrated tool for learning if they see the educator doing the same. Using the computer during whole and small group instruction and for recording stories and producing classroom signs and charts are ways in which the educator can be a highly visible user of technology (Bilal, 1998:45; Cedefop, 2001:38).

2.6.4 Critic

Responsibilities of the educator in the computer-enriched classroom, according to Bello (2003:37), begin before the computer is introduced to the learners. In providing a rich, challenging, and appropriate learning environment, educators must take an active role in selecting the software that will truly enhance learners' learning and development.

2.7 THE LINKS BETWEEN ICT AND LEARNING AND TEACHING

Learning about ICT, learning with the assistance of ICT and learning by means of ICT are three ways of educational ICT use. Learning about ICT is an essential precondition to learn with the assistance or by means of ICT, but is a component of them at the same time. Although the three functions are dealt with independently in this section, they will always occur in an integrated way in practice (Macome, 2002:53). The sequence of the functions mentioned in this section cannot be viewed linearly as "ICT is a building block of a powerful learning environment" that marks the end of an evolution starting with "learning about ICT".

Moreover, ICT is one learning resource amongst many others, therefore, the ICT option must be based on the added value it creates in the learning-teaching situation (Bilal, 1999:37).

2.7.1 Learning about ICT - computer and ICT literacy

ICT is a source of information, a means of communication and an infrastructure that learners have to learn to use efficiently. To this end, they have to acquire the necessary basic knowledge and in particular be able to

apply it (Garratt, 1998:67). Concretely, a number of basic technical and instrumental skills to use the computer, a number of necessary skills to use the basic software and to familiarise with ICT are discussed below.

ICT skills can best be acquired cross-curricularly and be integrated in a variety of learning areas. Learning contents inherent in the curriculum of specific courses – like learning how to programme – are not part of these basic skills. It is obvious that educators have an important task. Evidently they have to master these basic skills before they can teach them to the learners (Richard, 2003:30).

No matter who (the learners or the educators) has to learn (teach) these basic skills, this process needs embedding in a wide range of context-rich learning situations. An illustration here is learning how to use e-mail. Sending electronic post is not part of a specific learning material or area of learning, but is instructed in the context of communicating, for example with someone speaking another language within language teaching. As the evolution of ICT is a continuous process, learning about it will remain a permanent task within education (Antonacci, 2002:101).

Being able to use this new technology does not only imply that one has to master the technological knowledge and skills, but also that one has general knowledge, that is, knowledge, skills and attitudes to deal with information, to evaluate it and to process it into knowledge (Olivier, 1999:61). Having access to a wealth of information through ICT does not mean that one automatically masters this "knowledge". One has to have a number of skills to manage, organise and use this supply of information. Someone who does not have these skills, is overwhelmed by this flood of information that is characterised by its inconsistency (De Vries, 2003:83). Everyone who wants to "learn" something needs "meta-knowledge": this means the knowledge and skills to deal with knowledge. It is a kind of general knowledge that functions as a compass helping the individual to find his way through the flood of information. This general knowledge not only comprises the skills to process the information but also necessitates communicative and social skills to distribute and transfer knowledge (Gregory & Nixon, 2003:422).

Learners need assistance when seeking, selecting, processing and evaluating information. Of course, there are various systems that can offer some "navigation help". But they do not suffice. The ability to process information into knowledge requires more than navigation beacons (Trotter, 1997:11). Education has more than ever the task to develop a critical power among learners so that they can choose autonomously from the variety of information and decide which data have to be processed into "knowledge" (Watson, 2002:15).

The foregoing paragraph clearly highlights that education shall have to continuously pay attention to boosting a critical attitude, a debate culture and social skills and participation. In order to prevent that ICT widens the gap between high qualified people and low qualified people, it is of importance that education instructs general basic education as well as the necessary ICT literacy to learners.

2.7.2 ICT-assisted learning: ICT as a tool

ICT can take over several tasks of the learner and/or the educator. The computer takes over routine tasks and simplifies the attainment of a number of learning and teaching objectives (Beld, 2004:45).

Also this use of ICT is integrated in several learning materials, as some kind of tool assisting the learning process. ICT can be used for assignments, the assembling, selecting and processing of information and documentation, communicating with information resources, fellow students and educators, executing research, recording, dealing with and processing data and diagnosing, making (graphic) presentations, etc (Twigg, 2001:63).

Hardware and software carry out chemical and physical measurements and translate them into clear-cut tables and charts, do algebraic and geometric operations and transformations, ... For linguistic culture, history, geography and other social learning materials, databases can easily be kept up to date via Internet connections and combined with all types of representation such as texts, computer programmes, stationary/moving images and sound (Housego & Freeman, 2000:258).

2.7.3 Learning by means of ICT: ICT as an educational resource

ICT can be a helpful means to execute tasks more quickly and more efficiently and, in this way, (in)directly interferes with learning itself. In the mean time, this interference has become the central starting point for a large number of applications (Bailey, 2004:22).

As soon as ICT partly takes over the role of disseminator of (metacognitive) knowledge and skills, it is spoken of ICT-based learning. This means activities executed by the educators and learners themselves until now, with the aid of textbooks, handbooks and tests. The computer contributes to the social interactive learning process that provides ready knowledge or transforms information clusters into significant knowledge (Killen, 2000:17). ICT is used here in direct relation to concrete learning contents. There are three important dimensions of multimedia use: ICT as instructor, assessor and supervisor. Well known examples are the many application programmes and types of computer-based education by which the computer makes the learners exercise specific learning contents on the basis of concrete instructions. Also a number of pedagogical computer games (so-called infotainment) have this function (Pullas, 1997:28).

Automated assessment systems offer educators a number of advantages when drawing up, administering and assessing tests and examinations as well as processing them in clear tendencies and visual presentations. They save time and lead to quality improvement (Zehr, 1997:25). These automated assessment systems are also designed to give the learners the advantage to use them for self-assessment in each stage of the learning process. In this way they get a better understanding of the quality of their study approach and are better prepared to the actual final assessment (Brandl, 2002:33). Besides giving assistance in course writing (or independent learning packages) by integrating the course content, this type of software also delineates pathways to absorb the learning content at one's own pace. They contain a lot of possibilities to help the learner control his own learning process at his own speed, according to his own capacities (De Vries, 2003b:29).

One can speak of an intelligent tutoring system if it tries to take over the role of the individual coach. Such a programme indicates how one can deal with different learning contents and study them (Jakovljevic, 2002:63). It is interactive as it responds to the learner's attitude and to the level of knowledge and mastery this attitude reveals. Just like a good educator this system holds three types of knowledge: about the learning contents, about the learner who uses the system and about the best strategy to support the learner during his learning process (Candy & Bruce, 2000:15).

By means of an electronic learning environment the learner is able to experiment step by step and to correct his errors immediately. Communicative and negotiation skills can be practised virtually but in a sufficiently realistic way or within a real business environment (Jones, 1997:83).

Using ICT as an educational resource allows educators to differentiate as regards learning content and assistance in the learning process. This leads to experiences of success among learners and helps learners who are tired of learning to enhance their motivation to learn. These extra possibilities are not an automatic consequence of the decision to introduce ICT as an educational resource in a teaching/learning environment (Norris *et al.*, 2000:45).

There are a number of reflections that could play a crucial role in the social interaction that is necessary in the learning process. Some people think that ICT and the Internet in particular are not yet able to meet the high expectations. Indeed, some sources emphasise that there is little proof of effective learning gains as a result of learning through multimedia (Richard, 2003:31).

The same sources argue that ICT integration as regards support (the provision of infrastructure and training) is ahead of its educational aspects: the teaching methods and use of ICT. Compared to the many policy plans and the focus on infrastructure, relatively little attention is paid to pedagogical research and development (Bush, 1997:73). The indicators designed in the framework of the European eEurope policy plan "designing tomorrow's education" are typical of this trend. Almost all of them relate to infrastructure (the much talked- of learner/computer ratios) and training. From this point of

view, the criticism that didactics monitoring an efficient ICT integration are lacking, should be taken seriously (McCoy, 1999:33).

This does not necessarily mean that investments in infrastructure are superfluous. Indeed, it is evident from the preceding that a successful integration of ICT necessitates simultaneous measures in many fields (Salmon, 2000:16). Developing teaching methods, building a modern infrastructure; promoting adapted educational resources and fostering a permanent professional development are all part of that process, and a single aspect cannot be tackled without paying attention to another. However it should be clear to everyone that different actors are responsible for these different partial aspects. Each of the actors should be prepared to take this responsibility seriously (Agee & Holisky, 2004:105).

Other critics lay emphasis on the possible physical and psychological dangers of frequent computer use or of a premature introduction of it in education. An adapted infrastructure, a well-balanced computer use and a correct ICT use are issues on which the awareness- raising actions should focus (Trotter, 1997:7).

Finally, there is the critique that questions the added value of ICT – apart from learning. Until now, digital exchanges and participation in Internet forums did not stimulate social participation or reinforce social cohesion. Virtual communities appear to be rather poor reflections of social networks. These remarks are very true but should be confronted with the many and new possibilities of e-government and e-learning (Romaniuk, 2007:26).

2.7.4 ICT as a building block of a powerful learning environment

The different characteristics of ICT and the ways in which it can be used may prove to be an added value for learning and teaching. Indeed, ICT can boost the creation of an optimal teaching/learning environment, containing all components of the learning polymorph (Kafai & Bates, 1997:48).

In the most far-reaching implementation of a multimedia teaching/learning environment, all above- mentioned educational potentialities of ICT are integrated. In such a powerful learning environment the learner can choose

between various (combinations of) media to carry out his learning tasks (Chapelle, 1998:62). There are written and oral texts, still and moving images and sounds. Moreover, this environment has the advantage that it is interactive and fosters communication with people from all over the world. Electronic learning environments have an extra added value as they enable educators to exchange lesson preparations, course programmes and educational resources in a swift and efficient manner (Conole, 1999:35).

Furthermore, the initial knowledge as well as the expertise and the final skills of the learner can be checked with the aid of databases. On the basis of measurements the learning method and educational attitude of the learner can be discovered and then be translated in study hints and counseling (Johnson, 1997:162).

In this model, the learner is monitored to a high extent by programmes and materials (external monitoring), but also continuously makes choices himself (self-monitoring). He/she does not only base him/herself on the concrete situation but also on his experience with the assignments he has carried out until then. He/she can immediately obtain a definite answer because the online instructor follows and registers his/her movements and in addition gives him the opportunity or even instructs him/her to assess his/her progress (Viadero, 1997:14).

This teaching/learning environment model offers a wide range of possibilities to achieve the right balance between the independent search experiments of the learner and a sufficiently systematic guidance, taking the individual differences between learners into account (Perry, 2004:29).

It is evident that when describing this model it should be stressed that programmes and resources will never fully take over the necessary support and external monitoring of the learning process of the learners (Broens & De Vries, 2003:132). The educators and peers still are important actors in the guidance and support of the learning process of each learner, as learning will always be a social and interactive experience. During the learning process basic skills play a crucial role, as they stimulate explicit formulation of and

reflection on opinions, strategies, lines of thinking and solutions (Ankiewicz *et al.*, 2000:35).

2.8 ICT IMPACT ON THE SCHOOL ORGANISATION

The new vision of learning and the developments and innovations mentioned above cannot be dissociated from the educational organisation as a whole and the school organisation in particular. In the ICT policy as it has been practised in the past, a single aspect i.e. technology, was emphasised too much. If the introduction of ICT is to be successful and has to play a role in the broad educational innovation, other conditions have to be fulfilled, for example, investing in ICT means also investing in a learning environment and especially in people (Dede, 2002:43).

Learning processes at school are determined by the interaction of two aspects. On the one hand, the instructional aspects: the educational philosophy and its translation into didactical concepts. On the other hand, organisational aspects: the staff, operating budget, infrastructure and school policy in this field (Ropohl, 1997:66). It is evident that the school must have a sound vision of staff policy, staff development and the use of the operating budget in order to play its role in society. Extension of the special needs provision, internationalisation, pupil and parent participation, ICT-integration are among the general aspects of school policy (Wet, 2003:41).

In order to respond to the new visions of learning and to benefit from the opportunities provided, schools will have to continuously check their limitations and introduce innovations, i.e. the developments of ICT as part of the organisation itself. Schools must permanently reflect on their *raison d'être* and introduce flexibility in their organisational structure such as staff policy and policy strands (Tiene & Luft, 2001:23).

2.8.1 Staff policy

The description of the multimedia learning environment teaches that there should be reflection on the role of the teacher as well as on the new possibilities of a flexible and differentiated guidance. Staff policy in this regard should take alternative job descriptions into account (Williams, 2001:15). From

the latter statement it is evident that schools that want to realise a full- fledged ICT-integration, need a "change agent", that is, someone who has the educational knowledge to guide and motivate colleagues and management teams in the process of ICT-integration. He or she should have, in the first place, a vision and organisational talent, draws up an ICT policy plan and a phased plan to carry through innovation and should give advice on the different aspects (Kearsley, 1998:30).

Moreover, schools need a purely technical support. The network technology and the management of it are becoming so complex that they require the calling in of experts (Hara & Kling, 2000:46).

Although some steps have been undertaken, not every teaching team has enough initial skills to use ICT. Internal professional development in schools and among learning area teachers is indeed an important task. As an increasing number of schools become multimedia learning environments, the basic requirements for educational ICT-usage expand (Gregory & Nixon, 2003:423). This evolution calls for a continuous effort with regard to re-training and in-service training programmes at technical, equipmental and software level as well as at content level. Schools should in this regard conduct an efficient policy with regard to professional development (Barcelo, 2004:276).

Apart from in-service training of teachers, initial teacher training should follow suit. The (future) teacher does not only have to master ICT himself but also has to learn to effectively use ICT in his/her further career.

2.8.2 ICT policy strands

The general principles of: ICT-policy are:

- **ICT- policy should fit in with the broader framework of educational innovation**

ICT creates opportunities for the innovation of instruction in education. The described new didactical concepts – with or without ICT-support – have indeed an in-depth influence on the learning organization (Perry, 2004:30). This learning organisation will evolve in the course of time from schools into

open learning centres and multimedia learning environments. ICT must be viewed as a means that supports teaching aspects such as extension of the special needs provision, participation, internationalisation, lifelong learning and intercultural education. Therefore, in future, ICT should be purposefully integrated in these innovations (Conlon & Simpson, 2003:139).

- **ICT-literacy as a basic skill**

Being able to use ICT as a technology and all its information and communication possibilities, is a skill all learners should master when graduating. Also adults should be able to acquire this skill. The ultimate goal is integrating ICT in all learning areas and all educational levels (Garraat, 1998:63). This aim should best be achieved by making children use ICT from an early age (from nursery school). ICT-literacy should not be taught as a learning area in its own right. However, schools should make sure that learners acquire the necessary skills to smoothly apply the various possibilities. So using ICT cannot only be considered a means but also a target (Nagata, 1998:38).

- **ICT is an element of a powerful learning environment**

The educational added value of ICT will only pay off if it is combined with other teaching resources. Of course, schools' aims should not be a class without a teacher. Teachers must be able to guide learners in such a way that they develop reference frameworks for themselves which help them sort out information and process it into useful knowledge. Learners should have a critical attitude towards computers. Interpersonal communication and collaboration in face-to-face relations remain essential in the learning process (Mayes, 1998:377).

- **Schools and teachers are the key actors in the integration of ICT in education**

The integration of ICT starts with the schools and the teachers. It is of importance to put beginning ICT-users on their way and give enthusiastic teachers extra support. The teacher becomes the mentor and stands in the centre of the classroom instead of in front of the classroom (Rogers & Chow,

2000:5). In the medium term, schools should look different organisationally and architecturally. The introduction of ICT has an important influence on the entire education structure. That is why the collaboration and commitment of schools and teachers are essential to concretise the development (De Vries, 2003c:84).

- **The ICT-policy depends on partnerships of different actors**

Governments should in this respect:

- provide the necessary basic infrastructure;
- formulate pedagogical targets (attainment targets and educational objectives) and verify if the schools attain the above effectively; and
- support schools through good practice examples, research, development of training profiles, in-service training and pilot projects (Ankiewicz, Van Rensburg & Myburgh, 2001:94).

The *schools* are expected to make use of their autonomy to develop a policy plan in view of a high quality educational provision. This policy plan should contain:

- the state of development (where are we?);
- a vision (what are we aiming at?); and
- an action plan (how are we to make this happen?) (Bonk, Cummings, Hara, Fischler & Lee, 2000:14).

Teachers are expected to give proof of openness and willingness towards using ICT and to introduce the new media in their educational work. The *professional world* can support education by sharing infrastructure and providing training to use it. Of course, optimising the participation of all citizens in the knowledge society is not the task of education alone. In the field of adult education scale effects and job requirements will be created in collaboration with other education providers (Martinez-Lage, 1997:74). By means of pupil-oriented pedagogical methods within powerful learning environments, schools should develop learning processes which foster

enthusiasm and pleasure in learning. Therefore, co-operation with culture and youth work policy makers should be aimed at. One of the main actors is teacher training. The poor integration of ICT in teacher training is a restraining factor to educational ICT use. Together with teacher trainers, that is, universities, schools should examine how a wider take up can be achieved as soon as possible (Young & Figgins, 2002:144).

2.9 THE VISION OF INTEGRATING ICT IN TEACHING AND LEARNING SITUATION IN SOUTH AFRICA

The South African White Paper (2003) on e-Education views ICT as a resource for re-organizing schooling and as an educational tool for whole school development. Its aims is about connecting learners and educators to each other and to professional support services; providing platforms for learning; and to ensure that every South African learner is ICT capable by 2013. This success in the infusion of ICT into teaching and learning settings ensures that every learner is equipped for full participation in the knowledge society. The following are some of the government-driven programmes which are in line with the implementation plan of the White Paper on e-Education in South Africa:

- **KHANYA Project:** Khanya project is an initiative of the Western Cape Department of Education, which started in April 2001. The project looks at ways to use information, communication and audiovisual technology to improve teaching and learning in schools (<http://www.khanya.co.za>).
- **Gauteng Online:** The initiative for implementing ICTs in Gauteng schools falls under the umbrella of Gauteng Online (GoL) driven by the Gauteng Department of Education (<http://www.gautengonline.com>).
- **The National Portal initiative (Thutong):** Thutong is the Department of Education portal for all educators and learners, specifically aimed at those in grades R to 12. It has been created to support quality of teaching and learning in South Africa. The portal is part of government's intention, White Paper on e-Education, to turn South

African schools into centres of quality learning and teaching for the 21st century (<http://www.thutong.org.za>).

The White Paper on e-Education (2004) highlights the following as key elements of the e-education policy framework:

2.9.1 Equity, access to ICT infrastructure, capacity building, and norms and standards

The White Paper on e-Education (2004) addresses the equity principle in Chapter 4 and is of the view that there needs to be an equitable allocation of resources and that schools in rural and under-served communities should be prioritised to ensure that technology use in the education sector does not further exacerbate the digital divide within South Africa. In this respect, it would be worthwhile to consider alternative technological solutions, including the use of wireless and solar-powered technologies. These would help address the education needs of communities that do not have even the most basic of infrastructure, including electricity and landline telephony.

Once access to the ICT infrastructure is attained, regular, reliable and affordable access is required which is closely connected to the costs of basic telecommunication services as well as the cost of hardware and software ownership (Department of Education, 1999:7). This point once again relates to the intertwined nature of future e-education policy with telecommunications and trade policies. In a continuously changing society in which lifelong learning is a key principle, schools must be prepared to take on an educational assignment after school hours, which means that they should evolve into open learning centres (Jakovljevic, 2002:43). Making (expensive) ICT-infrastructure available to the local community should be one of their tasks. Besides, schools should also check the possibilities to make a more goal-oriented use of infrastructure through electronic learning environments. This means that ICT-integration should be carried through at all educational levels. Educators also need sound ICT-equipment for drawing up learning contents and preparing courses. As not all learners have a computer at home, schools should provide for a solid infrastructure which can be used by every

learner, student or learner outside school hours (Conradie & Jacobs, 2003:30).

With regard to capacity building, ICT can help empower existing teaching staff to deliver science and mathematics lessons at a time when the education sector has been hampered by the outflow from the country of experienced science and mathematics educators. Capacity building in terms of technology support training recognises the need for support of the technology end users (learners, educators, managers and administrators) (Cronje, 2001a:27).

The final element of the policy framework looks at norms and standards, following on current initiatives and donations of software and hardware, for example, Microsoft's donation of Windows XP to all of South Africa's 32,000 public schools (Cronje, 2001b:63). This Microsoft investment in South Africa will help tackle the digital divide and bring greater overall benefits to the country.

2.9.2 Strategic objectives

The Department has considered many of the factors necessary to ensure that its ambitious e-education goal is attained, and has captured them within the following strategic objectives:

- ICT professional development for management, teaching and learning;
- electronic content resource development and distribution;
- access to ICT infrastructure;
- connectivity;
- community engagement; and
- research and development (Department of Education, 2003).

Sections 1.7 and 1.17 of the White Paper (2003) identify the following criteria to the strategic objectives of e-Education which are linked to the key elements of the e-education policy framework mentioned in 2.6.1 above.

2.9.2.1 Physical access

The White Paper on e-Education (2003) considers infrastructure and connectivity in section 1.22, and provides an overview of some the initiatives various parties have begun to address the physical access criteria. The disparities in computer access are reflected through the statistics for schools per province. Section 5.32 is concerned with the provision of electricity and physical infrastructure. In this regard the Department of Education has collaborated with the Department of Minerals and Energy to prioritise the electrification programme for general and further education and training while also noting that there are ICT applications that use alternative sources of energy. Section 5.37 mentions that the education network will provide high-speed access for learning, teaching and administration.

2.9.2.2 Appropriate technology

Section 1.16 states that, through appropriate technologies, it is hoped that South Africa will leap-frog into the new century, by-passing the unnecessary adoption cycle, and implement a solution that works now, and has the capacity to handle further developments. This shows the Department's awareness of the exciting opportunities offered by cutting edge technologies as a means to circumvent excessive landline telephony costs.

2.9.2.3 Affordability

The Department acknowledges that any solution that South Africa adopts has to be cost-effective if South Africa is to meet its e-Education developmental demands and reach the most remote schools of its country. The Department has looked at the issues of investment for e-education.

2.9.2.4 Capacity

In the context of e-education, this element includes consideration of educator training, technical support and related high-level ICT skills capacities, as well as teaching methods that embrace e-literacy and skills development White Paper on e-Education (2003).

It is very encouraging to note that the Department of Education proposes in the White Paper on e-Education (2003) to bring researchers, educators and

members of the ICT industry (Chapter 5, Research and Development) to collaborate in forming programmes. The establishment of the Advanced Institute for Information and Communication Technology (AIICT) is a positive development in addressing human resource capacity building.

In section 5.46 dealing with community access, the White Paper on e-Education (2003) indicates the Department's hope that the local community will be involved in the maintenance and security of e-school ICT infrastructure, as well as supporting e-schools by availing ICT experts, specialists and champions in the community who are willing to volunteer their skills and expertise.

2.9.2.5 Socio-cultural factors

Section 3.9 lauds the applicability of e-education within the South African context, whereby it can be adopted by learners who represent a wide array of cultures, languages and social backgrounds.

2.9.2.6 Local economic environment

Engaging with SMMEs is in the context of providing technology repair services is mentioned in the White Paper on e-Education (2004). The White Paper indicates the intention for community members to utilise the e-schools facilities after hours and services for SMMEs should be included in this and that needs assessments and evaluations should be conducted in each community to ensure that the services offered by the e-schools are relevant and useful.

2.9.2.7 Political will

Sections 1.9 - 1.14 of the White paper on e-Education (2004) asserts that the Department of Education will invest in national initiatives to increase access, boost the capacity of managers, educators and learners, and provide electronic resources of the highest quality.

2.9.2.8 Funding and resourcing

The Department has a realistic appreciation of the fiscal constraints affecting the Government, the vast upfront investment required for e-education and the need for on-going and predictable funding sources for the longer term, and has identified a comprehensive source of funding, including license revenues, private sector donations and partnerships (White Paper on e-Education, 2003).

2.9.2.9 Implementation strategies

In the section "Co-ordination and collaboration", the Department mentions the establishment of a Ministerial e-Education Advisory Council consisting of ICT champions from the public sector, academia, and private and civil society. This is a shift in the right direction in that such a body will serve to streamline the process (De Swardt, 1998:53).

2.10 INTEGRATING COMPUTERS INTO THE CLASSROOM

In the early 1980s, the United States of America's education system approached computer literacy from a one-dimensional standpoint. Rather than viewing a computer as a learning tool, a computer was viewed primarily as a technical programming tool, as an end in itself. In the classroom, the concentration was on how to make the computer work, not on discovering how the computer could work with them and for them (Evans & Nation, 2000:63). While learning to write computer programmes involves a great deal of analytical and systematic problem solving talent, it is not the computer literacy solution for the public at large. Just as with foreign languages, some learners will be more proficient in learning a computer programming language, while others will find the logic unintelligible (Grabinger & Dunlap, 2000:36). But, when educators examine how all learners will be required to use technology in their futures, and how they can best benefit from technology today, learning a programming language is of little significance (Lee, 2004:21).

Parents, educators and learners all need to understand the value of using a computer for, *inter alia*:

- enhancing learning;
- creativity;
- productivity; and
- communications (Dresang, 1999:26; Osborn *et al.*, 2003:358).

Spotts (1999:39) opines that just as schools rely on pencils, dictionaries, work-books and text-books in more traditional classroom settings, they should come to rely on computers as modern-day learning tools. Unlike a workbook or textbook, however, computers and software are interactive and often more appealing to a learner. In fact, some software programmes even have digitized sound, which even allows the computer to "talk to" and "coach" the learner (Kramsch, 2000:45). Other types of classroom education tools, that is, from a pencil or pen to a dictionary or calculator, are used freely and effectively to augment the learning process. A pencil, for example, can be used to simply write mathematics problems, to trace over the pattern of a leaf, or to create intricate, detailed sketches. The pencil, like the computer, can be used in an infinite number of ways. Its "magic" is completely dependent on who is controlling it (Candy & Bruce, 2000:49; Huber & Morreale, 2002:64).

2.11 PRINCIPLES OF GOOD PRACTICE FOR INTEGRATION OF TECHNOLOGY IN TEACHING AND LEARNING

Section 2.9 above necessitates the discussion of the following five principles of good practice for integration of computer technology in teaching and learning.

2.11.1 The need to shift from 'education for ICT' to the use of 'ICT for education'

The above comments about the use of Office packages in educational institutions are of fundamental importance. To date, almost all initiatives that aim to use computers and the Internet in schools have focused initially on giving people ICT skills, in the expectation that once they have these they will be able to access a wealth of 'information' that will be of use to them.

Information, is not, though, the same as knowledge, and mere access to information is not what education should be about (Beld, 2004:46). Even some of the best initiatives, such as those developed by World Links (www.world-links.org/english/html/materials.html) and the Commonwealth of Learning (see www.col.org/programmes/training/toolkits.htm) have a tendency to focus primarily on ensuring that educators have ICT-skills rather than on the deeper processes associated with how the benefits of ICT, and particularly its networking potential, can be used in teaching. Computers are immensely powerful educational tools (Ayres, 2005:243). Their ability to enable interactivity in a multimedia (sound and vision) environment, to connect people in different places, and to store vast amounts of information in a small space can completely transform educational practices. These strengths of ICT have all too often tended to be subsumed beneath a rhetoric that emphasizes that educators and learners first need to acquire basic ICT-skills by partaking in lengthy and often expensive certified courses (De Vries, 2003a:18). Providing someone can read, and that they have reasonable hand - eye coordination, there are many examples of good educational software that they can start using in a matter of minutes, without having had the need to go on word processing or presentational courses (Treuer & Jenson, 2003:34).

Simple interactive software packages, such as *Webwise for Africa* (see imfun.do.digitalbrain.com/imfun.do/frontpage/webwise/webwise1.htm?verb=list%20), developed by the BBC in partnership with Imfun.do, and freely available for use anywhere in Africa, can enable educators in a few hours to learn all that they need to know about using computers and accessing the Internet, so that they can take advantage of educational software available in CD format or on the Internet (Telecentres, 2004:40). The key message that needs to be understood is that using ICT for educator training, and in education more widely, is about a fundamental shift in our ways of thinking. It is not about presenting existing educational content, such as books or posters, in a new way, but rather about enhancing the processes through which both educators and learners learn (Antonacci, 2002:65).

2.11.2 The need for ICTs to be integrated across the curriculum.

Acceptance of the above principle means that it is crucial for ICTs - including print media, audio, video, computers and the Internet - to be integrated throughout the curriculum in a blended way. Where computers are set aside in a laboratory, for use on only special occasions, they remain an object of curiosity, fear, uncertainty, awe or mystery, rather than being seen as the useful, enabling tool that they are (Dede, 2002:16). This has been neatly encapsulated in West (2003:24) first principle on the use of ICT in educator training: Technology should be infused into the entire educator education program. Throughout their educator education experience, students should learn about, learn with, and learn to incorporate technology into their own teaching. Restricting technology experiences to a single course, or to a single area of educator education, such as the methods courses, will not prepare students to be technology-using educators (Richard, 2003:30).

There are of course very real issues about access to computers in sufficient numbers, about security, about networking and about connectivity, but if we have learnt anything from the successful use of computers in education in Europe and North America in recent years it is that, particularly at primary level, it is of very much more benefit to have one or two computers in each classroom than it is to have them all together in a single laboratory. Computers, the Internet, video and the radio all then become part of the panoply of tools that educators have available to inspire, enthuse and educate their learners and students across the curriculum (Munn *et al.*, 2004:433; Martin & Rader, 2002:18).

2.11.3 The need for relevant and locally produced content

The importance of local content development is continually stressed in international meetings on ICT for Development (ICT4D). The first phase of the World Summit on the Information Society (WSIS) held in Geneva in December 2003 in particular emphasized the need for local content development (Lee, 2004:21) and scarcely an international ICT gathering takes place without a call for emphasis to be placed on the need not only to produce local content,

but also to train people across Africa in appropriate content development (Brantmeier, 2004:279). Yet despite this rhetoric, the picture on the ground is very different. There is very little multimedia content being developed by and for African people, let alone in local African languages. High quality multimedia educational content is expensive to develop, and companies with the experience of so doing are reluctant to lose market share by enabling local producers to expand their production of such resources (Ayres, 2005:242). However, there is little point in introducing computers into educational establishments across Africa unless there is appropriate content that they can bring alive. There are indeed examples of shareware and free educational resources on the Internet, but it is exceedingly difficult for users in Africa to identify what is most appropriate for their needs (De Villiers, 2000:120). Moreover, even where educators may have access to the Internet, the bandwidth connectivity is usually so low that download times can preclude use of much of what is available. In this context, it is remarkable that few donors have yet sought to identify and bundle appropriate and relevant multimedia software for educational use in Africa on CDs (Wilson & Wong, 2003:155). There needs to be a fundamental shift in priorities, from the present emphasis on putting hardware into educational establishments to the creation of appropriate content and software relevant to the needs of the many different education curricula in Africa (Agee & Zenelis, 2002:93).

2.11.4 The need for real partnerships

The complexity of the processes needed to deliver the above principles makes it increasingly important for ICT for educator training initiatives to benefit from the potential that partnerships between governments, the private sector, civil society, academic institutions and global organizations can provide (Bonk *et al.*, 2000:57). At present, and particularly following the WSIS meeting in Geneva in December 2003, there is considerable interest in delivering educational ICT initiatives across Africa. African governments are eager to use ICTs so that they are at the forefront of technological change; donors and international agencies are eager to provide resources to help 'bridge the digital divide'; the private sector is keen to invest where companies

see potential market growth possibilities in the future; academics are interested in sharing the results of their research on the subject; and civil society organizations are willing to help facilitate delivery of schemes on the ground (Kerr, 2005:1005). However, this multiplicity of interest means that there is frequent duplication of effort, lessons are not sufficiently learnt and shared, and there is a wasteful lack of coordination in the activities that actually take place (Williams & Coles, 2003:28). There are many examples of small-scale initiatives, embarked on with the best will in the world, but that only benefit a few people for a short while. If all those involved, would truly work together for the interests of the poor and marginalized in Africa, rather than primarily for their own agendas and targets, it would be possible to achieve very much more than has heretofore been achieved (Reddy *et al.*, 2003:27).

2.11.5 The need to build sustainability into programmes from their inception

A final principle that cannot be stressed enough is the need for sustainability to be built into the conceptualization of programmes from the very beginning (Crabtree *et al.*, 2002:49). Across the world, even in affluent countries, schools have difficulty in finding sufficient funds to renew computers, to pay for Internet connectivity, to cover the costs of maintenance, to purchase new generations of software, and to pay for consumable expenditure on paper and ink (Brandl, 2002:45). If external agencies were not involved in providing computers, be they new or refurbished, for educational establishments across Africa, it is doubtful whether more than a tiny proportion of existing initiatives would have been funded (Large & Beheshti, 2002:70). Ministries of Education in Africa are resource poor, with almost all of their resources being needed to pay for educators' salaries. When decisions are made as to the desirability of introducing new technologies into the classroom, real cost calculations need to be made, which take into consideration the long-term running, maintenance and replacement costs of such initiatives, and how they will be paid for (Housego & Freeman, 2000:260).

2.12 COMPUTER ILLETERACY AND LITERACY

In this section factors that lead to computer illiteracy and steps towards achieving computer literacy will be discussed.

2.12.1 Factors that lead to computer illiteracy

The foregoing revelations from the literature on the value of the computer in the classroom lead to the following question, which will be answered in this section: With all the potential they offer, why have computers not been integrated into regular classroom instruction and become key parts of every learner's classroom learning experiences? (Basney, 1999:417)

The literature provides the following reasons, some economic and some social, that need to be tackled in the coming years.

On the economic side, computer equipment and the myriad of software programmes beneficial to a learner's educational development cost real dollars or rands in the case of South Africa (Bonk *et al.*, 2000:33). Many years ago, there were no computers in schools. Now, imagine if this year, every school in the country had to buy all new textbooks and all new desks and chairs for the more than 45 million (Department of Education, 1999:22) learners enrolled in primary and secondary schools in the country. The cost of doing this would be astronomical, literally, out of control. That is what schools are facing with purchasing computers and software (Burns-Glover, 2001:35). Slowly, schools are building an inventory of equipment and software and making sufficient quantities available to educators and learners. This trend needs to continue if computer proficiency among learners and educators is to become a reality (National Academy Press, 2001:4).

Today, the national average of computers to learners is 1:15. According to different sources, there are over 3 million computers in South African public schools. Additionally, over 95 per cent of all primary and secondary schools now have at least one computer for instructional use, compared to 18 per cent just ten years ago (Scottish Executive, 2003b:47). Unfortunately, these statistics mask the fact that thousands of these computers are older models

and do not provide learners with the full benefits which newer technological products offer. While the Department of Education is making strides in addressing the critical shortage of computers and software, schools still need more funding to ensure that all learners gain good access to computers and that the equipment they have available are current, not out-dated technology. Plus, schools need to ensure that learners and educators have several current computers in every classroom, not just in the computer laboratory (West, 2003:63; Taylor, 2001:4).

However, the critical issue according to Williams (2001:14) really comes down to:

- What is the cost to individual growth and the nation's long-term stability of not making sufficient numbers of current models of computers and software available in schools?

Although it is difficult to measure, anyone could argue that the cost of not properly preparing learners by far exceeds the capital costs of the computer equipment and software needed by schools to allow as many learners as possible to have good access to computer and software technology (Fullan, 2003:28; Graham, 2002:227).

Beyond these bottom line economic considerations, what other challenges do we face in our efforts to prepare our youth for the 21st century? Training nearly three million pre-primary, primary and secondary school educators in South Africa to learn how to more effectively integrate computers into their classroom lessons is a formidable challenge. To achieve computer literacy among the nation's learners, educators must first become computer literate (Jossey-Bass, 2000:10; Heath, 2003:38).

Brown (1999:30) opines that in the coming decade, educators will continue to be the key to the success of a national computer literacy programme. However, because the vast majority of educators today did not grow up in the "computer generation," a low per centage of them are comfortable with or have had formal training on computers and other exciting new technology products. The *Power On!* study indicates that almost two-thirds of American

educators have had less than 10 hours of training on a computer. Imagine an educator who was unable to read, educating learners on the fundamentals of reading and writing. That is the challenge schools face as educators attempt to make learners computer literate (Hoven, 1999:33; Callison, 2003:49; Perry, 2004:37).

Business, government agencies and national non-profit foundations such as the Computer Learning Foundation, need to continue to provide educators with the resources and support needed to fuel their understanding of and effective classroom integration of computer technology (Fulton-Calkins, 2003:59; Valdez *et al*, 2000:22). The Computer Learning Foundation, for example, supports educators' efforts by serving as a clearinghouse of information on teaching methods for integrating technology in the classroom. The Foundation offers numerous resource guides filled with lesson plans written by educators from throughout North America (Todd, 2000:79).

As more and more educators realize the potential of computers as classroom learning tools, their enthusiasm and example will undoubtedly inspire learners to discover how much they can achieve with a computer (Pauw, 2002:40). To support educators' efforts, educator training and graduate education programs need to provide educators with the proper resources and information on teaching with computers, not just teaching about computers (Treuer & Jenson, 2003:34). Educators currently earning their credentials are generally exposed to computers through courses on computers. These courses instruct future educators on how a computer works, that is, from identifying the parts to describing the technology behind the system. Ideally, educator-training programmes should provide educators with methods and skills for integrating computer technology into all learning areas (Viadero, 1997:18). The value and effective use of computers and software should be integrated into all methods courses, not taught only as an isolated course. *Power On!* points out that less than 30 per cent of all learner educators in 1988 felt they were ready to teach with the aid of a computer, while more than 90 per cent felt they were ready to teach with "proper" or more traditional methods such as workbooks and drills (Cole, 2000:30). These numbers indicate a need to re-evaluate the types of

courses available to educators and to strengthen the focus towards courses that provide practical information for using computers more effectively in classroom instruction. These courses need to support educators in their efforts to better leverage what is one of the most powerful teaching tools available to learners in the post-modern era (Phillips, 2000:123).

According to Martin and Rader (2002:46); Warschauer (1997:74) and Crabtree *et al.* (2002:22), many community-based non-profit groups are addressing the needs of the nation's "at-risk" learners. Computers and You in San Francisco and Playing to Win in Harlem are examples of two after-school programmes that are introducing at-risk learners to computers to enhance self-esteem and promote a positive attitude toward learning. Through corporate-sponsored programmes such as "The Hartford Early Learning Partnership" (run in conjunction with The Travelers Companies Foundation), businesses are also reaching out to address the needs of developmentally unprepared learners through the use of computers. By bringing computers into pre-primary schools' classrooms in Hartford, Connecticut, the programme helps develop problem-solving skills and build a sense of accomplishment and interest in school activities among learners at an early age (Follansbee, 1997:18; Tiene & Luft, 2001:31).

Pullias (1997:29) maintains that schools need to encourage more community facilities, as well as their facilities, to make technology more accessible to learners. For example, increasing numbers of schools are setting up after-hours programmes in which learners can use the school's computers and related technology products to expand their learning and to help them complete their homework.

The following section describes factors that lead to computer illiteracy that are related specifically to obstacles to computer integration at the school level. The integration of computers in the school context requires that there should be proper planning and also commitment from all the stakeholders in the school driven from above (Coutts *et al.*, 2001:227). "Lack of a clear vision, lack of leadership, lack of critical mass, lack of incentives and lack of faculty participation were found to be obstacles to successful integration of

computers in the classroom” (Eurydice, 2004:102). In the endeavour it is necessary that each of these aspects be looked at because one affects the other. It is essential for stakeholders to recognise that these aspects might exist in one way or another when considering the integration of technology in the school curriculum (Loertscher & Woolls, 2001:63). However Hargreaves (2003:44) found that the lack of equipment, time, classroom help, and lack of relevance, mismatch with classroom management style and lack of confidence were the most observed obstacles to technology integration. However for the purpose of this study the themes that are covered under obstacles to computer integration in schools are: leadership, lack of vision, planning and lack of commitment. They are discussed below:

- **Leadership**

Use technology by top management people is motivating aspect for educators to try and implement technology into their teaching. According to Salaberry (2000:28), if leadership is not using technology at the top, then the educators don't see it filtering down. The top management should be able to set the pace for the educators to be able to implement technology successfully. According to Brandl (2002:118), research literature about technology integration frequently mentions the need for administrative support for educators to be successful. Educators should be provided with unqualified support in order to achieve the desired results. McCoy (1999:374) also contends that educational institutions fall short of the support required for active and productive teaching and learning experiences for educators that the benefits of implementation. According to Candy and Bruce (2000:54) the leadership should also be clear why they want to use information and communications technology in any future approach to curriculum development.

- **Lack of vision**

It is not uncommon for most educational institution to require the integration of technology without clear vision. According to Richard (2003:30), lack of clear vision on the part of the institution itself provide the first obstacle to the whole

school situation's technology integration. Without a clear vision, which must also be communicated to other stakeholders at the school, technology integration might be a futile exercise to engage in.

- **Planning**

Planning is required for a successful integration of computers for instruction in education. According to Doczi (2000:39), planning usually starts with the identification of an instructional goal. However Housego and Freeman (2000:260) have found that "many educators use the computer only for a drill-and – practice, tutorial, games and simulations with little or no planning". This they contend lead to undesired consequences for learning. Technology integration requires making commitment and re-looking at the many aspects of teaching and learning. These require proper planning strategies to be developed for technology integration to succeed. Because of lack planning, many educators remain relatively ill-prepare to deal with increasingly important technology issues (Maddux *et al.*, 1999:43).

- **Lack of commitment**

Cecchini (2003:22) found that "reluctant educators" is a universal problem in an attempt to integrate technology at the school level. There are some educators who cannot figure out exactly how technology can help them in their teaching if they use it as a tool. Mostly they hold back until at least they feel it or they see others using it productively and successfully (Moore, 2000:83). However if proper planning is done this would not be much of a problem. Therefore, it is critical to carefully examine just where and how computer use is likely to be most effective in advancing well thought out educational goals (Jegede, 2002:18).

2.12.2 Steps towards achieving computer literacy

Hall and Martin (1999:187) maintain that educators, parents, learners, government agencies, community groups and corporate members of countries need to focus their efforts on teaching learners how to use computers and software as tools in their every day lives. The computer, in this sense, is a

means to an end, a part of today's education and learning solution, not an end in itself (Twigg, 2001:25).

In the early 1980s, following the introduction of the personal computer, many primary and secondary school educators discovered how to use a computer. At that time, schools began introducing computer courses (Eurydice, 2001:58; Bates, 2000:45). These courses focused on teaching computers as ends in themselves (i.e., how they work and how to programme them), not as means to an end (i.e., as tools to assist with other tasks) (Jones, 1997:83). Once proficient with the hardware, these educators went on to discover how to use a variety of software programmes. This led to numerous software courses such as, *inter alia*:

- word processing;
- databases; and
- desktop publishing (McCoy, 1999:37; Nagata, 1998:62).

While this is a step in the right direction away from courses on computers, this approach teaches software as an end in itself, not as a means to an end (Williams & Coles, 2003:60).

Candy and Bruce (2000:40) posit that schools need to ensure that all educators understand the value of computers and software as educational tools, as well as the importance of integrating learner's experiences with computers and software into all areas of the curriculum. Schools need to expose all learners to using computers and software as a means to an end, not ends in themselves (Honey *et al*, 1999:18). For example, in writing instruction, learners might be shown how to use a word-processing and desktop-publishing programme to produce written work more quickly and to enhance the appearance of the finished product. Clearly to reach this level, educators must first have a solid foundation in knowing how the hardware and software operate (Bilal, 2002:70). The ultimate emphasis, however, must be placed on how these tools can be used to enhance a learner's learning

experiences, at school and at home, and eventually, in business (Garraat, 1998:19).

To achieve the goal stated in the latter paragraph, Conole (1999:21) suggests that computers should not be just a separate course taken in the computer laboratory every other Friday. And, when learning about computer software, courses should not only focus on programming languages and creating the programmes, or on how to operate a software programme. Instruction needs to focus on how the software programmes can be used in areas of learner's lives, for example, in preparing a research paper. When using computers, they should enhance and add to a learner's learning experience, as well as an educator's teaching capabilities (Met, 2004:16). Rather than replacing educators, the computer can help educators teach things they could not teach before. Computers can help educators improve upon methods previously available to them and take learners to worlds they have never even imagined (Bush, 1997:37).

According to Bates (2000:48), one step toward computer proficiency is to be able to use the computer as a learning, creativity and skill development tool. With different software programmes, computer users can extend computer technology in totally new and unique directions. When a learner wants to really understand, that is, to both see and to hear, how musical notes sound in different compositions, the computer can assist (Moore, 2000:65). Or, when a learner needs to create a map of the world, the computer can assist. And, when a teenage boy needs to gather information and write a term paper on what it is like to grow up in South Africa, the computer can assist (Hall & Martin, 1999:187).

From the literature findings in this sub-section, other questions arise, namely:

- How can parents and educators encourage learners to become computer literate and prepare them for the 21st century?
- What activities, at home and at school, should be included in a learner's programme to increase computer literacy among learners?

These questions will be answered in the following sub-section.

2.12.2.1 Making computer literacy happen

Simply encouraging learners to work on the school computers, and if possible, making computers available at home as well, will start the ball rolling. The key is to provide learners with the opportunity to experience using computers and software as tools for learning and other areas of their lives (Chapelle, 1998:29). The enthusiasm and intrigue expressed by learners using a computer for the first time is an amazing sensation that continues to build as the learner becomes more proficient with the computer and different software programmes (Brantmeier, 2003:74).

The Computer Learning Foundation has identified the following six key areas that all learners should be exposed to in using computers and software as tools. Tools for:

- learning;
- creativity;
- productivity;
- research;
- communications; and
- entertainment (Valdez *et al.*, 2000:31; Coutts *et al.*, 2001:227; Kuh, 2001:15).

As a learning tool, computers can:

- help develop memory skills;
- offer after-school study or tutoring sessions; and
- allow learners to experiment and investigate abstract science and mathematics concepts through simulations (Osuna & Meskill, 1998:21; Barcelo, 2004:277).

Eurydice (2004:28) asserts that as a creativity tool, computers provide access to an infinite colour palette and fine-tuned keyboard, which keeps learners busy creating art and music. As a research tool, computers offer learners access to information that was not available at their school or local library (Loggett & Persitchitte, 1998:34). As a communications tool, computers and software can enable learners to share experiences with their next-door neighbour or with other learners as far away as Europe or China, all electronically (Coley *et al*, 1997:49). As a productivity tool, computers and software programmes such as word processing, databases and spreadsheets can also help learners work more efficiently (Crabtree *et al.*, 2002:26). And, as an entertainment tool, computers and various game softwares keep learners involved for hours; and just like Monopoly, many entertainment programmes help learners develop important skills (Mercadante, 2002:57).

2.13 COMPUTERS AS E-LEARNING TOOLS

As learning tools, computers can be used as follows:

- **Memory practice**

Regardless of whether it is multiplication exercises or spelling, there are certain facts that learners must learn through memorization in their early education. And the key to learning these is memorization (Hamilton *et al*, 1999:299). Computer software is available to provide learners with memory recall exercises, that is, from mathematics facts to science definitions to English vocabulary words (Kearsley, 1998:35). Using a computer to practice facts is fun, which for most learners means spending more time with the exercises. Computers are also infinitely patient, and (unlike many of us) will work with a learner even if it takes 100 tries before they provide the correct response. Plus, learners receive instant feedback, that is, no more waiting until the next day to see the results, so learners do not practise mistakes (Aplevich & Willment, 1998:56).

- **Tutoring**

There are times when a learner needs extra tutoring help and possibly a different approach from the way that an educator has presented the material during class. Computer tutorials offer learners a new approach to the learning area, as well as one-on-one assistance (Mayes, 1998:377; Todd, 2000:76). Many educational computer software programmes are designed to present information in a step-by-step manner and allow a learner to catch up on the steps and concepts they were not able to understand in the formal classroom setting. With computer tutorials, learners are free to work at their own pace (Maddux *et al.*, 1999:46).

- **Experimenting**

While no educator or parent can allow learners to experiment with dangerous chemicals unsupervised or to cut up cadavers to see just how human body parts fit into place, computers can (Tapscott, 1999:10). Science and mathematics simulation software programmes make these and other worlds come alive, safely, right on the screen. The programmes encourage learners to learn through discovery and experimentation (Conroy *et al.*, 1999:11). Even medical learners rely on experimental interactive learning tools to help guide them through their courses of study. With the help of a computer, for example, medical learners can run through a series of exercises that challenge them to diagnose and treat "computer" patients (Williams *et al.*, 1998:52).

Brandl (2002:28) maintains that experimenting with computers goes well beyond the science and mathematics laboratory. Asking "what if" questions about historical facts can help learners draw their own conclusions and increase their memory and understanding of the results (McKenzi & Murphy, 2000:241). At the same time, simulations allow learners to pretend that they were there during different periods of history. Simulations help learners develop decision-making skills, which are critical for learners' futures (Casey, 1997:31). In social studies simulations, for example, learners learning about South African history can actually make decisions and, from within their

computers, change the course of history for a minute and see what would have happened (Jones, 1997:92).

2.13.1 Computers as creative tools

Some learners shy away from art and music because they are not immediately proficient using traditional tools (Follansbee, 1997:27). And, even though they have a wealth of creative ideas, they fail to express them because others in the class seem to be better painters or composers. With computers, all learners have access to a new array of creative tools, that is, from computer painting and drawing tools to musical composition and desktop publishing programmes, making it easier for them to express and explore their creativity (Norris *et al.*, 2000:46; Heath, 2003:38).

2.13.2 Computers as productive tools

With computers, productivity is always on the rise. Word processing and data-base management programmes help learners, young and old, organize their thoughts and information (Sachs, 2000:33). For example, if a high school learner uses a computer and a word-processing programme to prepare a term paper, there is no problem revising the first page. Before computers, the learner would have been forced to re-copy the entire document, but with a computer, they simply key in the changes and re-print. By making written communications easier, computers cannot help but boost learners' productivity and communications skills (Munn *et al.*, 2004:439; Wilson & Wong, 2003:157; Killern, 2000:22).

2.13.3 Computers as research tools

Bilal (2000:647) identifies another area that learners can explore with the help of a computer and a data-base programme. Now, pulling together background information on a topic takes on new meaning. Besides the traditional resource materials such as encyclopedias, books, etc., there are software and computer tools that provide learners with access to on-line database information and research reports. In addition, there are a number of research

analyses and organizational tools available (Devit & Palmer, 1999:138; Brantmeier, 2004:280).

2.13.4 Computers as communication tools

Like the telephone, computers have the power to bring people closer together. Through networking technology, computers across the room or across the world can be connected to allow people to:

- communicate;
- share thoughts; and
- information (Osborn *et al.*, 2003:367; Large & Beheshti, 2002:78).

Learners in the United States and Russia, for example, have recently established electronic "pen-pal" relationships. Through an electronic mail programme and modems, learners in each country can tell each other about their activities. Through these types of electronic communication links, learners can strengthen their ability to express themselves in writing and prepare themselves for the increased use of electronic communications in the workplace (Valdez *et al.*, 2000:13; Richards, 2000:52; Simpson & Payne, 2002:34).

2.13.5 Computers as entertainment tools

Broockfield and Preskill (1999:52) maintain that computers can be a lot of fun. In addition to finding educational software programmes, there are a number of entertainment software titles available that can keep learners "working" on the computer for hours. Besides just being fun to play, many games are educational in nature and many others develop eye-hand coordination and strategy skills. Played alone, with a friend or parent, these games can also help to bring people closer together, even if it is in the spirit of computer competition (Kerr, 2005:1014; Burns-Glover, 2001:14; Jossey-Bass, 2000:12).

Computer manufacturers and software developers are doing their part to produce some state-of-the-art products that will help our learners learn more,

and just as importantly, to enjoy learning (Callison, 2003:52). The key for parents and educators is to increase a learner's access to computer technology and encourage them to explore the possibilities (Mooij & Smeets, 2001:279).

2.14 INTEGRATED LEARNING SYSTEMS VERSUS TRUE INTEGRATION

The term "integrated learning" has gained popularity over the past half-decade, evidenced by the appearance of numerous prepackaged reading, mathematics, and science curricula on the pages of educational software catalogues. Unfortunately, these well-marketed packets are often no more than unrelated activities clustered around a single topic and give little consideration to the development of larger concepts or goals (Evenbeck & Kahn, 2001:44; Jones, 1997:84).

According to Anderson (2003:29), Honey (2001:61) and Broens and De Vries (2003:68), these misnamed integrated learning systems view a topic, such as dinosaurs or planets or fish, as only a series of superficially related activities and isolated skills linked casually together in sequence, much as a worm appears to be no more than a chain of loosely attached segments that can be severed and still function independently. Real knowledge is much more than a group of unrelated segments; each section supports a particular function, and all are related to one another. If the severed pieces are thrown into a box (brain) and shaken up without the support of their natural connections, neither the worm nor deep understanding will grow (Graham, 2002:234).

True integration respects the interrelationships of the disciplines such as among many others, language, mathematics, and science as natural and necessary to achieving the goal of becoming educated about a particular topic. As in the "project" approach (Condie *et al.*, 2002:93), learners exercise all the developmental or curricular domains as they complete self-initiated projects individually or in small groups. For example, if the educator selected the topic "Fish" for integrated study, the first step in planning might be to define several central concepts about fish that are meaningful and relevant to the learners' lives. Next, activities might be chosen based on the desire to

further explore these concepts (Lee, 2004:20). The educator would then determine the most effective medium for supporting the activities selected. Sometimes computers will be the most appropriate material for concept exploration; at other times, they will not. Computers, like any learning material, are neither a panacea nor pernicious (Norris *et al.*, 2000:48).

2.15 EXAMPLES OF COMPUTER USE IN INTEGRATED CURRICULA

When exploration of a concept encourages learners to write letters, stories, poems, or reports, using a word processor allows learners to compose, revise, add, and remove text without being distracted by the fine motor aspects and tedium of forming letters. Research demonstrates that learners who write on word processors compose longer and more complex stories, are less worried about mistakes, and are more willing to revise (Campbell & Salazar, 2004:53).

The educator implementing the unit on "Fish," for example, might use the LEARNER PIX programme with very young learners to construct a story through pictures and labels that can be narrated in the learner's own voice by recording through the computer's microphone (Wright *et al.*, 2000:117). With LEARNER WORKS 2, learners might write and draw what they have learned about fish and hear their composition read back. Slightly older learners could use CD-ROM encyclopedias to gather data and STORYBOOK WEAVER to compose and illustrate original stories and reports about their topic (Fullan, 2003:36). MY WORDS, a simple programme, can be used to write letters to local experts asking for information or extending an invitation for a classroom visit. Any one of these programmes provides an excellent medium for educators to record a group report or story (Bailey, 2004:21; Loertscher & Woolls, 2001:24).

One of the most powerful uses educators can make of computers is to provide learners with a MICROWORLD (a microworld is software with which learners play and discover concepts and cause-effect relationships included by the software developer for this purpose), a bridge between hands-on experiences and abstract learning, in which learners can learn about a topic through exploration and experimentation (Heath, 2003:39). An example is EZ LOGO,

which is often used to introduce young learners to geometric concepts in a playful way that is intuitive to them, just as one might use blocks to teach size and shape relations. Microworlds are developmentally appropriate software programmes that are harder to find than are drill-and-practice programmes, but that are much more valuable (Young & Figgins, 2002:145).

For example, ODELL DOWN UNDER allows learners to explore the ocean's ecological interactions by becoming a fish, with all the abilities and vulnerabilities of the particular species selected. ZOOKEEPER and SAN DIEGO ZOO PRESENTS THE ANIMALS! give learners the chance to examine the habitats of several aquatic creatures (Hemard & Cushion, 2003:129). Graphics programmes, such as COLORFORMS FUN SET provide learners with the tools and props to construct their own underwater environment (Chalhoub-Deville, 2001:54).

2.16 SOUTH AFRICAN CURRICULUM 2005, THE INTEGRATION OF COMPUTER TECHNOLOGY, AND SOME MAJOR LANDMARKS OF ICTS IN EDUCATION IN SOUTH AFRICA

Curriculum and learning areas' content development in the government education system in South Africa is a function of specialist divisions within the Departments of Education. The National Department of Education assumes responsibility for development of the core curriculum, Curriculum 2005 (Department of Education, 2002:26). This, in turn, is interpreted and implemented at provincial level by the various provincial Departments of Education. The selection of learning materials and examinable content is shared between individual schools and provincial Departments (Department of Education, 2000:13). Schools assume a primary responsibility in this regard at the General Education and Training (GET) level, and provincial Departments of Education are responsible for the Further Education and Training (FET) level, in particular at matriculation level. Examinable education outcomes at provincial level are directly informed by the national core curriculum (Ankiewicz & De Swardt, 2002:29).

Curriculum 2005 does not exclude the integration of ICTs into the curriculum; in fact, it welcomes their use where they may be appropriate to achieving educational outcomes. However, it does not make special provision for the use of ICTs, nor does it offer specific guidelines on the use of ICTs in the core curriculum. Furthermore, the outcomes have not been designed in such a way that they require the use of ICTs in meeting them (Ankiewicz *et al.*, 2000:45; Ankiewicz *et al.*, 2001:95).

In South Africa, the use of technology in education has been on the policy agenda since late 1995. As the country emerged from apartheid rule, the first democratic government was faced with a plethora of educational problems. Both within and beyond policy circles, several people began to turn greater attention to the possibility of using a range of information and communication technologies to find solutions to these problems (Broens & De Vries, 2003:133; Cronje, 2001a:39).

This interest brought with it a proliferation of technology vendors marketing technological 'one-size-fits-all' solutions, particularly to the national Department of Education. In response, the Ministry of Education and the Department of Education initiated the Technology-Enhanced Learning Investigation, in order to establish a clear policy framework for the effective use of technologies in education (De Swardt, 1998:29; De Vries, 2001:17). In 1996, the Minister of Education published a call for nominations of persons to serve on an investigating committee relating to the development of a national framework and a strategic plan for technology-enhanced learning. This led to the following series of policy processes (De Vries, 2003a: 20):

2.16.1 The Technology-Enhanced Learning Investigation framework and its role in addressing ICTs in the South African education system

The Technology-Enhanced Learning Investigation establishes a clear commitment to using technologies in education and training. It stresses the importance of examining teaching and learning environments in depth before choosing which technologies to integrate into those environments. It also considers the need to identify strengths and weaknesses of different

technological options, and uses these to inform decisions (De Vries, 2003b: 132). The Technology-Enhanced Learning Investigation framework stresses the danger of allowing technology choices to drive educational decisions about how to integrate technology use into teaching and learning environments (De Vries, 2003c: 85).

Garratt (1998:44) maintains that Technology-Enhanced Learning offers a decision-making framework as a strategy for overcoming problems. The aim is to fit appropriate technological choices with the educational contexts in which they are needed to make sure scarce resources are used as effectively as possible. The framework contained in the Technology-Enhanced Learning Investigation discussion document poses challenges implementing and planning a technology-enhanced learning strategy, and provides a starting point for an investigation of different technologies to support education and training (Somekh, 2000:22). The intention of this approach is to guard against technologically driven educational projects, which do not always provide effective or sustainable educational solutions (Ankiewicz *et al.*, 2000:287).

2.16.2 Centre for Educational Technology and Distance Education

The Centre for Educational Technology and Distance Education was established in early 1997 as a sub-directorate of the Ministry of Education, and was a direct outcome of the Technology-Enhanced Learning Investigation process (Ankiewicz *et al.*, 2001:94). Its mandate was to “promote open and lifelong learning through the use of media, educational technology, libraries and distance education” (SADE) (De Swardt, 1998:154). The centre set out policy guidelines for the educational sector, supported the use of technology through research, coordinated initiatives and organised partnerships between the government and the private sector (De Vries, 2003b: 135).

In South Africa, education is a provincial matter. The Centre for Educational Technology and Distance Education therefore did not have direct authority over the implementation of initiatives at school level (Ankiewicz *et al.*, 2000:59). However, it was instrumental in many initiatives at the national level, which have had indirect effects on the use of ICTs in education. For example,

the Centre for Educational Technology and Distance Education, together with the IDRC, played an important part in the founding of the national SchoolNet South Africa initiative, set up in November 1997 (Cole, 2000:38).

The original TELI documents outlined 19 related projects, of which six were identified as lead projects undertaken by the Centre for Educational Technology and Distance Education:

- doing an audit of ICTs in South African schools;
- carrying out research and producing a report on the role of technologies in supporting the development and provision of education and training through multi-purpose community learning centres (De Vries, 2001:28);
- developing technical standards and protocols for educational technologies (De Vries, 2003a:15);
- establishing a clearing house of information – a tender for the design and development of a website of information relating to technology-enhanced learning initiatives in South Africa was awarded. A printed version of aspects of the information available on the website was made available, and distributed quarterly as part of *The Educator* (De Swardt, 1998:56);
- co-ordinating school library services, which included investigating the future of library services and norms and standards for school libraries (Fry *et al.*, 1999:365); and
- working with the South African Broadcasting Corporation to produce comprehensive reports relating to a school-based educational broadcasting service for South Africa, and educational broadcasting interventions in the fields of adult education and youth development (Broens & De Vries, 2003:98).

The Centre for Educational Technology and Distance Education also developed a framework of quality standards for distance education. This was important, because it contained value statements that could be used to

measure the quality of a technology-enhanced learning project (Broens & De Vries, 2003:254).

2.16.3 Vision of a national educational technology network

The concept of an educational technology network implies a need to roll out technological infrastructure on a large scale. In this regard, the report proposes judicious investments in networking teaching and learning sites (including schools, adult learning centres, health clinics, multi-purpose community centres and a range of other potential sites) around cluster hubs (Ankiewicz *et al.*, 2001:98). Via a wide area network, these hubs would provide access to network servers for the teaching and learning sites connected to them. They would provide connected sites with the full functionality of a distributed computer network, including access to:

- websites;
- email facilities; and
- centrally stored database systems (Carr *et al.*, 1999:433; De Vries, 2003a:17).

Several projects now being launched either at provincial level or through the involvement of private sector partners have brought in sizable investments. In 2000, SchoolNet South Africa, for example, was managing projects that led to the installation of networked computer laboratories in over 300 schools (Broens & De Vries, 2003:387; Garratt, 1998:28). Gauteng Online.Com, a provincial project of the Gauteng Department of Education, constitutes a R500 million provincial investment in ICT between 2001 and 2003, while there are similarly ambitious plans presented in the Khanya Project of the Western Cape Department of Education (Ankiewicz *et al.*, 2001:106).

The above processes led to the establishment of a national ICT forum, which was jointly launched by the Departments of Education and Communication early in 2001. This forum intended to bring together private and public sector

players to support implementation of the vision of a dedicated national education network (Broens & De Vries, 2003a:28).

2.16.4 Conceptualising and launching of the SchoolNet South African project

SchoolNet South Africa had its forerunners in a few local Non-Governmental Organizations founded by educators with the aim of providing computers and Internet access to schools. However, most of the Non-Governmental Organizations suffered from lack of funding and infrastructural support (De Vries, 2003c:86). To secure and extend their work, the local Non-Governmental Organizations considered the establishment of a national umbrella organisation and approached the IDRC for support. During 1997, the IDRC brought together possible partners and started negotiations between the local Non-Governmental Organizations and the government (De Vries, 2003c:86). It was eventually decided that the Centre for Educational Technology and Distance Education would coordinate the initiative and SchoolNet South Africa would be set up as an independent entity (De Vries, 2003a:9). Its mandate stipulates that the organisation should stimulate ICTs in education and the support of educational systems in four main areas:

- Connectivity and technology;
- Human resources development;
- Online content and material in function of the curriculum; and
- Marketing and promotion (De vries, 2003a:21; Ankiewicz & De Swardt, 2002:24; Ankiewicz *et al.*, 2000:18).

The organisation was unique in the South African context in that it was managed by an executive council comprising representatives from Non-Governmental Organizations, the Centre for Educational Technology and Distance Education, the Department of Arts, Culture, Science and Technology, the Department of Communication, and the Department of Trade and Industry (Gauteng Department Of Education (GDE) & Gauteng Institute

for Curriculum Development (GICD), 1999:19). Initially, SchoolNet South Africa's funding largely originated from donors and international organisations. By 2001, however, much of the funding came from the private sector, either in terms of direct funding or through delivered services and infrastructure (International Technology Education Association (ITEA), 1997:20). Since its inception, the IDRC has funded SchoolNet South Africa, financially and in kind. Contributions in kind included the housing of the secretariat within the IDRC's Regional Office for Southern Africa (ROSA) in Johannesburg, and administrative support associated with the financial management of the project (Jakovljevic, 2002:18).

Jakovljevic *et al.* (2003:267) maintain that through its operations, the organisation has shown that partnerships between the public and private sectors can yield considerable benefits. SchoolNet South Africa has been able to promote and widen the use of computers and the Internet in schools.

The global objectives for SchoolNet South Africa were conceptualised around three core theme areas. These were further sub-divided as follows:

- to develop provincial structures and networks in the nine provinces. In the two provinces with appropriate provincial networks, SchoolNet would support existing structures and use well-established schools as pilots and reference sites for the next activities. In the four provinces with emerging networks or existing initiatives, SchoolNet would build upon existing structures and establish new provincial School Net structures, implement connectivity projects, establish training and resources centres and run training and human resource development projects. In the other three provinces, SchoolNet would establish relationships with provincial government and NGOs to initiate the formation of school networking structures (Jones, 1997:91; Johnson, 1997:163).
- to develop human resources at the provincial level. The model for implementing human resource development would be based on the WorLD-training programme. Various training schemes would be implemented at the provincial, district and school levels. Training would be

provided in basic ICT literacy, use of ICTs in education (using WorLD and other appropriate material), technical ICT support and information technology facilities management and sustainability (Killen, 2000:20; Antonacci, 2002:36); and

- to provide national support in the areas of learning and teaching resources, connectivity and technology, and human resources *development*. This would include the promotion of appropriate ICT-based learning and teaching resources, exploration of alternative ICT infrastructural and connectivity options, coordination of relevant training resources, and research to determine best practices for implementation (Mawson, 2003:127; McCormick, 1997:149; McCormick & Davidson, 1996:236).

According to International Technology Education Association (ITEA) (1997:19), these objectives formed the core of activities during the first phase of SchoolNet South Africa. Specific objectives were to pilot a provincially based school connectivity implementation model in four provinces – the Eastern Cape, KwaZulu-Natal, Northern Province and North West province. The implementation strategy is described in terms of the following specific objectives:

2.16.4.1 Monitoring and evaluation of SchoolNet South Africa's activities

SchoolNet South Africa aimed to assess its overall achievements through on-going monitoring and evaluation of its outcomes through the following measurements:

- four functioning provincial school network organisations, established with the involvement of the stakeholders (Jones, 1997:96);
- a model for expansion into other provinces and into other countries in Africa (Mayers, 1998:376);
- a number of functioning connectivity hubs and training sites able to provide appropriate support to surrounding schools (McCormick, 1997:142);

- a number of connected schools participating in ICT learning projects as contemplated in the broader SchoolNet South Africa programme (Jones, 1997:85);
- the value of the key educator concept in providing connectivity in support of educators involved in educator development programmes (Jakovljevic *et al.*, 2003:261);
- the value of a geographical approach to access in providing connectivity within reasonable travel distances of target educators and learners, e.g. through telecentres or education resource centres (Jones, 1997:89); and
- a technology map of the minimum hardware and support requirements for achieving various ICT-based education outcomes, as well as the constraints determined by the lack of resources available for technology in the country (GDE & GICD, 1999:19).

To evaluate the project, SchoolNet planned to access:

- the prospects for sustainability, i.e. continued use of ICT facilities after one to two years (Killen, 2000:18);
- educational outcomes from the use of the ICT facilities, and the extent to which these matched the targeted learning areas and supported the work of other projects involved (ITEA, 1997:34); and
- the technical success of the project, i.e. the extent to which the provided Internet connectivity was used (Lan, 2000:12).

Some of the projects undertaken by SchoolNet South Africa have warranted detailed, independent evaluations. For example, the Telkom 1000 School Internet Project (described later in this chapter), as well as a project in collaboration with the Open Society Foundation (also described later), was evaluated by outsourced, specialist evaluation agencies (Jones, 1997:17; Jakovljevic, 2002:29). SchoolNet South Africa has evaluated other projects internally on an ongoing basis, both during implementation as well as upon

completion of projects and interventions (GDE & GICD, 1999:18; Jakovljevic, 2002:28). This evaluation needs to also be undertaken at school level.

Assessment is an important driver in education and, if not well - managed, can become a barrier to innovation (Intelecon research, 2000:18). Once ICTs are embedded in learning and teaching reform processes, it can be effectively used, in conjunction with other methods, in assessment.

- e- learning will require educators and learners to reflect use of e - learning and teaching reform process, it can be effectively used, in conjunction with other methods, in assessment, approaches and strategies to teaching and learning. This will have an impact of the skills levels of the educator as a assessor. The efficient use of e - learning methodologies has the potential to enhance the quality and value of assessment (Arzika, 2000:15; Wijewardena, 2002:60).
- Data analysis techniques can assist educators to track learner achievements and review teaching strategies according to the insights gained. Educators will also be able to give learners immediate feedback on progress, identify areas of weakness, and design necessary and appropriate support systems in a timely fashion (Bowie, 2000:44; Agee & Holisky, 2004:39).
- The administration of assessment is a labour – intensive exercise. The use of ICTs in assessment has the potential to increase the efficiency and to streamline and safeguard data – transfer processes (Olivier, 1999:30; Gregory & Nixon, 2003:422).
- ICTs have the potential to simplify the administration of assessment. Time saved by educators on administrative routines can be spent on giving direct support to learners and improve the quality of contact time (Macome, 2002:49; Watson, 2002:28).
- In adult education and training, online assessment has the potential to increase participation by overcoming barriers such as location, time and cost through “on demand assessment.” Adult learners who progress at

their own pace and wish to demonstrate skill acquired at the workplace should not be tied down to an inflexible timetable (Cronje, 2001b:62; Brennan & Rowe, 2004:9).

2.16.4.2 Networking and shaping of computer technology and ICT's activities IN AFRICA

SchoolNet South Africa was pivotal in establishing and shaping SchoolNet Africa, an initiative to support national school networking programmes in African countries. SchoolNet South Africa participated in a regional networking workshop in Cape Town in October 1999, which led to the Cape Town Declaration (Jones, 1997:96). Representatives were nominated to present the conclusions of the workshop at the African Development Forum held in Ethiopia in November 1999, which identified SchoolNet Africa as a development priority. In addition, SchoolNet South Africa played an important role in the formation of SchoolNet Namibia through working with the Namibian SchoolNet director and being involved in initial planning activities (Jakovljevic, 2002:23).

SchoolNet South Africa also contributed towards the research design and interpretation of data of a "Computers in Schools" survey commissioned by the IDRC from the Education Policy Unit at the University of the Western Cape (ITEA, 1997:187). This report, published in May 2000, provides a snapshot of the state of computer technology and ICT use in schools in 1998, with valuable data on many aspects of computer provisioning and use (Jakovljevic *et al.*, 2003:278).

2.16.4.3 Developing technical services

SchoolNet South Africa, in response to requests from schools for specialised email and Internet services that would meet the specific needs of educators, established a number of technical services to underpin its school networking activities. These activities generate revenue for SchoolNet South Africa, and the SchoolMail service is provided on a subscription basis (ITEA, 1997:187; Mawson, 2003:124).

2.16.4.4 Providing SchoolMail

SchoolNet provides the SchoolMail service, which was launched in September 1998 and is operated by the Western Cape Schools Network. School-Mail is a multi-user dial-up service that provides more effective and cheaper access to e-mail for schools than standard services available through ISPs (Jones, 1997:84). Established with support from Uniforum and the Internet Service Providers' Association, the service uses the dial-up networks of MWeb and Telkom's SAIX. Server hosting is donated by Intekom and UUNet (Mawson, 2003:118).

2.16.4.5 Managing domain administration

SchoolNet is responsible for managing the second-level Internet domain name "school.za", and for ensuring appropriate management of the third-level provincial domains (such as ecape.school.za) (Killen, 2000:48). Domain names allow schools to have their own unique and permanent Internet locator, which is independent of the particular ISP or access technology that they use. Domain registration is a free service for schools (Killen, 2000:30).

2.16.4.6 Providing Website hosting

Provincial schools networks provide website hosting services for member schools, as a benefit of membership (Mawson, 2003:124).

2.16.4.7 Providing leased-line connectivity

The Western Cape Schools Network and the Gauteng Schools Network provide leased-line connectivity to schools, re-selling band-width from a commercial ISP. As at the end of March 2000, both networks provided Internet connectivity to twenty-seven sites with a combined total bandwidth of four-hundred-and forty kilobytes per second (Jones, 1997:45; Jakovljevic *et al.*, 2003:265).

A significant number of schools, especially in provinces other than Gauteng and the Western Cape, obtain leased-line connectivity directly from commercial ISPs (Jakovljevic, 2002:20).

2.16.4.8 Net-Day

Net-Day, a non-profit section 21 organisation that empowers schools and assists with accessing ICTs, was started by SchoolNet South Africa and Sun Microsystems. Sun Microsystems provides funding to ensure that low-cost solutions are provided to schools and management to guarantee the success of the organisation (ITEA, 1997:35; McCormick, 1997:147; Johnson, 1997:165; Jakovljevic *et al.*, 2003:624). The project is not restricted to a few partners, as all corporate citizens can be involved in the deployment of computers and related technologies to schools. The concept originated in America in 1995, and has since spread to more than ten countries, including South Africa (Mawson, 2003:119).

Net-Day's main aim is to provide low-cost technology solutions to schools, community-based organisations and community facilities through:

- Refurbishing of old computers;
- Implementation of low-cost networking options using new and refurbished equipment; and
- Technical skills development (Mawson, 2003:128; Antonacci, 2002:36).

There have been many challenges, particularly the opening of the first operations and refurbishing facility at Springs College for re-conditioning old computers. As part of a solution for schools, the organisation includes an empowerment component that teaches refurbishment skills. Net-Day encourages interns to write examinations towards receiving A+ certification. Four technical interns were trained in 1999/2000 (Jakovljevic *et al.*, 2003:256).

Net-Day installations throughout the country include the networking of computers (cabling), provision of SchoolMail and Internet access, and basic training in maintenance and use (Jones, 1997:84).

The study by SchoolNet South Africa has found that at Kettlehong High School:

- not one of the 11 computers had been connected to the electrical power supply and there was no network in place (GDE & GICD, 1999:17);
- despite great excitement and animation from the principal about the possibilities that computers could provide, no computer lessons had in fact begun at the school. These were due to start later (McCormick & Davidson, 1996:236);
- the computers were not used at all during the school day from 08:00 to 14:00 on the grounds that it was impossible to share the 11 computers fairly between the 1,600 learners in the school. Lessons were offered to groups of 11 learners after school hours in the form of a three-month course in basic computer literacy (Mawson, 2003:119);
- learners had to pay R100,00 each for the course on a first-come, first-serve basis. The course ran on two afternoons per week, with the laboratory closed to learners on the remaining days of the week. All but one learner that had been accepted for the course were in Grade 12, which suggests that their seniority in the school played a role. The one exception was a Grade 11 learner who was the acknowledged computer expert of the school (Jones, 1997:87);
- the reason given by the learner group for attending the course was their desire to improve their academic results quickly, given that the school-leaving examinations were approaching in October. They possessed a mistaken confidence that a three-month crash course in computer literacy would improve their results in conventional subject disciplines such as mathematics and English (Lamy & Goodfellow, 1999:56);
- during the visit to the school, two interns from the Kettlehong resource centre arrived to undertake some maintenance work on a computer. The opportunity to speak to them was utilised, during which they delivered a

scathing attack on the local educators who, despite training and retraining, had to be shown how to log into the system and surf the Web every time they returned to the centre (Jakovljevic, 2002:29);

- there was a perception that the science educators could make the best use of information technology; educators that had been trained by SchoolNet South Africa saw themselves as fortunate in having had that opportunity and indicated a need for training on the Internet (Jakovljevic *et al.*, 2003:283); and
- educators felt that the principal had no real understanding of computers (Moreland & Jones, 2000:291).

2.17 CONCLUSION

This chapter started by clarifying all concepts that are used in this research, the theoretical framework was then discussed. The current status of classroom technology in South Africa and other countries was discussed. Factors that lead to computer literacy were analysed.

The next chapter deals with the empirical design employed in this research.

CHAPTER THREE

EMPIRICAL DESIGN

3.1 INTRODUCTION

This chapter presents the research methods employed during the process of data collection of this study. Both quantitative and qualitative research methods were employed to:

- investigate the nature of technology integration into the teaching and learning practice;
- investigate ways in which schools have integrated technology into learning;
- investigate ways in which schools have integrated technology for professional development of educators;
- investigate if there is an equitable accessibility of technology to learners in schools;
- investigate if necessary resources are available to implement technology in schools; and
- make recommendations for schools to integrate technology into their teaching and learning curricula.

The rationale for the choice and selection of the mentioned methods of research is explained (see 3.2 below).

The use of interviews and questionnaires was seen by the researcher as the most appropriate and practical technique in reaching the aims of this study. Questionnaires and interviews as methods of data collection were, therefore, explained in this chapter.

3.2 RESEARCH METHODS AND CHOICE OF THE INSTRUMENT

The aims of this research were stated in sections 1.2 and 3.1 above, and they were based on the research questions posed in section 1.1. Both quantitative and qualitative research methods were chosen for this research. The use of mixed methodologies did not only permit triangulation of the data to improve the validity of the findings, but also enabled greater inferences from the results. According to De Vos (2001:359), data triangulation attempts to gather observations through the use of a variety of sampling strategies to ensure that a theory is tested in more than one way.

A two-phased approach suggested by Creswell (2003:163) was used in the collection of data in this research. The first phase was quantitative where questionnaires were distributed to principals, educators on post level one and computer managers. The second phase was qualitative where either a principal or an educator on post level one or a computer manager was interviewed from each of the ten schools selected for qualitative research. The advantage of the two-phase approach is that the two paradigms are clearly separate (De Vos, 2001:360). It was necessary to include a qualitative phase as, according to Seidman (1998:65) and Creswell (2003:44), one of the features of qualitative research is that it is interpretative in character, i.e. the inquiries try to account for what researchers have given an account of (by asking themselves questions, for example, why should computer technology be integrated in teaching and learning situations) and thereafter collect the responses from educators.

This interpretative character of qualitative research described above, is in line with the survey method considered for this research (Merriam, 1998:62). Surveys are used to learn, among other things, about people's attitudes, beliefs, opinions and values (Marshall & Rossman, 1999:73). This corresponds with qualitative research in that qualitative research also enquires about attitudes, i.e. why people behave in the manner they do when in their natural settings (Patton, 2001:96).

Qualitative research concentrates on verbal responses and approaches are not limited to formality. The scope is less defined, less structured and data appears as words (DeMarrais & Lapan, 2004:48). Flick (1998:18) argues that qualitative research is a foundation aimed at covering various methods and approaches into the inquiry of human behaviour. It includes exploring the world of people interviewed, researching their background and examining the information gathered with the purpose of establishing the meaning of facts being provided. What people perceive tends to expose how they think things should be, whereas what is initially identified is more likely to reveal how things are, especially when field observation extends throughout an adequate period of time (Strauss & Corbin, 1998:56). In the context of this research, the views of principals, computer managers and educators about the integration of computer technology in teaching and learning situations were established.

Bogdan and Bicklen (1998:66) contend that, by trying to understand and observe a problem, qualitative research may enhance the following elements of endeavour related to educational intervention in the identified patterns of human behaviour, namely:

- establishing which causal factors can be influenced and which cannot; and
- predicting transformation that might be introduced in the domains concerned.

In the light of the previous paragraphs, the qualitative research method may be explained as a guideline which produces descriptive information as engaged in people's own written or verbal words and identified behaviour rather than in figures. This implies that the correct meaning of perception on the integration of computer technology in teaching and learning situations held by principals, computer managers and educators should be deduced (Seidman, 1998:18). Strauss and Corbin (1998:57) further assert that qualitative research interprets reality as interactive and as a distributed experience viewed by individuals. In this research, different perceptions by participants on the integration of computer technology in teaching and learning situations are examined and relevant conclusions are reached.

In order to realize the establishment of relationships, to offer an explanation of the causes of changes in measured social facts and to establish context-free generalizations, the researcher also employs the quantitative method of research, through graphs (see chapter 4) to a limited extent in this predominantly qualitative research (Patton, 2001:26).

3.3. RATIONALE FOR CHOOSING THE QUALITATIVE AS WELL AS QUANTITATIVE RESEARCH METHODS

These research methods were considered with the purpose of revealing what benefits can be achieved when computer technology is integrated into the teaching and learning situation. Due to the evidence that various people view the world differently, responses of principals, computer managers and educators are sought in order for relevant conclusions to be drawn. The qualitative method of research is viewed as appropriate for this research because it becomes possible to measure the reactions of many people to a limited set of questions, thus facilitating direct comparisons between people (Denzin & Lincoln, 2005:40).

3.3.1 The qualitative method

The word qualitative signifies that emphasis is placed on processes and meanings, not accurately scrutinizing or measuring in terms of quantity, amount, magnitude or frequency. The socially assembled nature of reality is stressed; answers are sought about questions and subsequently given meaning (Berg, 2003:44).

Qualitative inquiry gives rise to new questions, expands the frame of reference of the individual and enables the examination of evidence in a productive manner. Qualitative researchers also concentrate on natural settings as they are interested to discover new insights. Nothing is taken for granted, and they want those who are studied, to speak for themselves (Cresswell, 2003:35; Flick, 1998:18). In this research 10 educators from 10 different schools in the Vaal-Triangle were interviewed. An interview schedule was drawn up and the participants were interviewed in the time of their convenience (see Addendum B). All interviewees were interviewed in English

as they all understood the language. The interviews were tape-recorded and later transcribed.

Finally, qualitative investigation broadens the understanding of educational research by extending the researcher's frame of reference. It provides a means of counteracting rationalization of researchers and assists them to search for universal and infinite generalizations. In present research, the qualitative method of investigation should provide constant truths pertaining to the concept of the integration of computer technology into the learning and teaching practice (Marshall & Rossman, 1999:49).

Kvale (1996:77) indicates that the following important concepts be applied by the qualitative researcher:

- qualitative research is designed to discover what can be learned about a phenomenon of interest;
- qualitative research has various interpretations. It reveals logistics and the relevance, which has an influence on the readers. It enables a researcher to gain insights about the nature of a particular phenomenon. It develops new concepts or theoretical perspectives about the phenomenon and also discovers the problems that exist within the phenomenon;
- impressive conceptions, related to the origin of truth of the world, the nature of certain situations, settings, processes, relationships, systems, or people, are revealed;
- the focus is based on the respondent's ideas and experiences;
- simple events in their original situations display aspects of real life in the research process;
- it assists in the justification of correct life skills and the future success of the individual;
- it stresses identification, induction and formulated theory;

- it involves the respondent's observation in detailed interview and conversational analysis;
- it allows a researcher to test the validity of certain assumptions, claims, theories and generalizations within real world contexts; and
- it provides a means through which a researcher can judge the effectiveness of particular policies, practices and innovations (Shank, 2002:33).

Qualitative methods enable the researcher to investigate selected matters in depth and detail, while quantitative methods compel standardized measures to be used in order that the perspective and experiences of people could be placed into strategies which are predetermined and to which numbers are allocated (Merriam, 1998:62).

3.3.2 The quantitative method

DeMarrias and Lapan (2004:97) explain that quantitative data deals principally with numbers while qualitative data deals with meanings. These meanings are expressed through language and action (Denzin & Lincoln, 2005:67). Like meanings, numbers are important at all levels of measurement in research. Numbers must be based on meaningful conceptualizations. Quantitative and qualitative methods complement each other for meaningful research (Bogdan & Bicklen, 1998:66).

In present research, school principals, computer managers and educators are the respondents to questionnaires (n=370). One of the most important requisites in contemporary social science is that scientific information should be quantitative because it represents an endeavour to detect laws, relationships and explanations of various occurrences. Results obtained in such a way are always transcribed in a statistical manner. The extent into which observations are translated into numbers serves as an indication of the maturity of science (Demarrais & Lapan, 2004:48). Quantitative research measures the reaction of many people to a limited set of questions, thus

facilitating comparison and statistical aggregation of the data, which give a broad, general set of findings (Strauss & Corbin, 1998:89)

In order to reach the correct conclusion for this research, it is important to focus on the character of a research instrument.

3.4 CHARACTERISTICS OF A RESEARCH INSTRUMENT

An imperative attribute of research instruments is the existence of reliability and validity, the latter being the most important characteristic (Marshall & Rossman, 1999:55). Denzin and Lincoln (2005:33) postulate that research is a scientific method of enquiry, thus information should be carefully assessed by means of reliability and validity focuses on the trustworthiness (Cresswell, 2003:45), which invites explanation of phenomena reliability and validity. Validity involves what is intended to be evaluated and for whom it is relevant, whereas reliability includes the consistency with which the instrument appraises whatever should be measured (Flick, 1998:23).

3.4.1 Validity

The relevance, meaningfulness and usefulness of conclusions made by researchers, can be defined as the validity thereof (Marshall & Rossman, 1999:52). Bogdan and Bicklen (1998:34) state that validity is employed to guarantee that information includes everything it should and that it does not include anything that should not be included. Validity is the way of discovering a true and precise picture of what is claimed to be described and is dependent on the purpose in which measurement takes place (Kvale, 1996:62). The results of a questionnaire and interview can therefore be valid in one situation and invalid in another.

Validity, therefore, is the degree to which a survey instrument evaluates what it purports to measure (Berg, 2003:63). For instance, the research of the integration of computer technology into teaching and learning situation is valid if the researcher formulates and asks questions that are relevant to computer technology as an effective tool in effective school curriculum delivery.

A more appropriate definition of the concept validity is provided by Shank (2002:166) below.

Validity is concerned with the accuracy of scientific findings. Establishing validity requires: determining the extent to which conclusions effectively represent empirical reality, and assessing whether constructs devised by researchers represent or measure the strategies of human experience that occur.

The functionality of present research is to ascertain the concepts pertaining to computer technology integration into schools.

Reality is represented in the questionnaire (see Addendum A) used in this research by posing questions, which are relevant to the concepts of computer technology in schools and supported by the fact that it is relevant to human experience as well. Therefore only school principals, computer managers and educators were requested to complete related questionnaires. Accurate interpretation of results can only be made if the group to be studied precisely conforms to specified standards in all aspects.

To obtain validity, Denzil and Lincoln (2005:40) and Cresswell (2003:52) claim that the researcher has to employ standards which may have a meaningful link with research questions and with data analysis, in order to direct him/her in creating valid arguments, findings and reports. This emphasis is considered with the idea that validity is a single, unitary concept that requires evidence for the specific use that it cited. The questions posed in the questionnaires are of such a nature that ambiguity should not occur in response. Reliability, dealing with the consistency with which an instrument evaluates, is closely linked to the concept of validity.

3.4.2 Reliability

Reliability refers to the consistency of measurement to the extent with which the results are similar over different forms of the same instrument or occasions of data collecting (Flick, 1998:25). In other words, the same results are obtained each time the researcher uses various techniques for assessing

the collected data (Maxwell, 2004:11). Charles adds that reliability, in ordinary terms, means dependability or credibility. With respect to measurement, the meaning is similar. The ratio, to which a test constantly measures what it is intended to measure, is referred to as the reliability thereof. If a reliable test were to be re-administered, the scores obtained would essentially reveal similar scores the second time.

Reliability directly points to the consistency of the scores acquired. If scores are inconsistent they provide no useful information and cannot be declared valid. If reliability of a test improves, the validity improves as well (Merriam, 1998:32).

The questions contained in the questionnaire, and those that were asked through interviews are aimed at concepts relevant to the integration of computer technology into the teaching and learning situation and the way in which such integration can develop teaching and learning which safeguards that only relevant responses will be given. If respondents are given another questionnaire to complete, they are not likely to change their opinions about this matter. Consequently their scores would be similar, which indicates the reliability of the items (Patton, 2001:13).

Validity has been verified in this research by the fact that another measure of the same variable was supplied by administering a basically similar issue dealing with the issue of computer technology to all the participants involved in the research. Reliability has been verified by the fact that a similar dealing with the issue of computer technology has been administered to all respondents involved.

After the research problem had been defined, related literature was reviewed and the questions stated, careful thought should be given to sample selection and data collection. The next section does that.

3.5 POPULATION AND SAMPLE SELECTION

Seidman (1998:22); Shank (2002:12) and Strauss and Corbin (1998:70) postulate that sampling is a process of choosing a small group of participants

from a defined population. They further define sampling as the scientific research in which a number of individuals are stakeholders in establishing a concise conclusion about a large number of people.

Sample selection is the primary technique used to collect data and the manner in which cases rich in information present themselves. The reasoning behind sampling is associated with the purpose of the research as well as the research problem studied (Marshall & Rossman, 1999:40).

Demarrais and Lapan (2004:61) state that when an educational design is in the planning stage, the researcher should take the population, to which the results should be generalized, into account. Such intention should involve decisions over sample sizes and sampling methods. Qualitative research is mainly focused on the description of the site and sample (Maxwell, 2004:74). In this instance, questions regarding where, how and with whom a particular phenomenon prevails, may be asked. Denzin and Lincoln (2005:62); Berg (2003:46) and Flick (1998:13) emphasize the importance of a selection strategy, which should be employed in order to achieve the sub-set of the population from whom data is collected by means of interviewing, observation and documentation. It is therefore important to conceptualize sampling as an aspect of research.

This research has chosen a specific population, which comprises school principals, computer managers and educators in Vaal Triangle area of the Gauteng Province of the Republic of South Africa.

3.5.1 Description of the population

All principals, educators and computer managers falling under the jurisdiction and control of the Gauteng Department of Education were considered as the study population.

The Gauteng Department of Education has 9 800 educators, computer managers and principals in public schools. Seeing that the carrying out of the study could be delayed if the researcher were to send questionnaires to such a big number of participants, which would have had particular financial and

time implications for the researcher, it was not regarded by both the researcher and the supervisor as practically feasible. After consultation with the study supervisor it was decided to limit the study population to principals, educators and computer managers in the Vaal Triangle area of the Gauteng Province.

3.5.2 Method of sampling

Samples like cluster and random sampling were considered for use in this investigation. After careful consideration of the advantages and disadvantages of each of these methods, it was decided on random sampling. This type of sampling was chosen because each member of the population has an equal and known chance of being selected. This is also the purest form of probability sampling (Denzin & Lincoln, 2005:24). A list of all public schools and tertiary institutions (those that have computers), that is, further education and training institutions from D7 and D8 districts in the Vaal Triangle was obtained and schools and tertiary institutions for investigation were selected randomly from the list. The respondents consisted of principals, educators and computer managers from randomly selected primary, secondary and tertiary institutions in the Vaal Triangle.

Educators who are computer managers and members of School Management Teams were approached by the researcher to ask for their permission to participate in the interviews. Those who were willing had to confirm the time and the venue the meeting. This type of sampling was purposeful as all participants had undergone training offered by Gauteng On Line.

3.5.2 Sample size

A total of 370 principals, educators and computer managers from 18 public schools, participated in the survey they were all issued with questionnaires. Ten schools participated in the interviews. At least one educator per school was interviewed from these schools. The total sample for this research is (N=380). This sample ranged from remote areas to metropolitan areas and

also included participants from primary, secondary schools and tertiary institutions.

3.5.3 Questionnaire distribution

The method of distributing questionnaires to be collected after three days created problems for the researcher – not all questionnaires were returned. Only 370 questionnaires out of 500 distributed were returned. The table below indicates the numbers distributed to principals, educators and computer managers, and those that could be retrieved and those that were lost or misplaced.

Table 3.1: Feedback from the population group

No distributed	No. received	No. lost or misplaced
500	370	130
100%	74%	26%

3.5.4 Individual interview procedure

Individual interviews were conducted with 10 educators from 10 schools in the Vaal-Triangle. The interviews were structured (see Addendum B). An interview guided was created for the purpose of this study.

All interviews were audio-taped with participant permission to facilitate transcription. In addition, notes were taken during the course of the interviews to assist in the compilation of data and to give the participants the sense that their information was important motivating them to provide more details.

3.5.5 Covering letter

In a covering letter to the principals, educators and computer managers of 18 primary, secondary schools and tertiary institutions, the purpose of the questionnaires was described. Stressing the confidentiality of information, an appeal was made to the respondents to respond openly and sincerely.

3.5.6 Procedure

With the permission of school principals who agreed and were known by educators and computer managers not to have access to the completed questionnaires, copies of the instrument were distributed by the researcher to educators, computer managers and principals of the participating schools.

Written guidelines and personal briefings were provided to ensure as far as possible standardized administration, and to secure respondents' guarantee of confidentiality. Principals, educators and computer managers were given three days to complete the questionnaires, which were to be collected by the researcher on the afternoon of the third day. All data were collected during January 2006.

Structured interviews were conducted by the researcher (see Addendum 2). Individual interviews were conducted as all participants indicated that they would be comfortable if interviewed individually. All responses were tape-recorded and transcribed by the interviewer.

3.5.7 Feedback on the questionnaire from the participants

The questionnaire feedback from the sample of the participants was as follows:

Table 3.2: Teaching designations

Teaching designations	n	%
Principals	37	10
Computer Managers	93	25
Educators	233	63
Missing	7	2
Total	370	100

Table 3.3: Location of schools

Location of schools	N	%
Town	8	21
Township	25	67
Farm	4	11
Missing	4	1
Total	40	100

More schools from the townships participated than schools in either town or farm. This was due to the fact that there are more schools in the townships than in town or farms. It was impossible to have 100% retrieval of questionnaires as many of them were reported to have been lost or misplaced, as they were collected on the third day. Eighteen principals, educators and computer managers claimed that they had misplaced the questionnaires.

3.6 DESIGNING THE QUESTIONNAIRE AS A MEASURING INSTRUMENT

Although several instruments have been devised to obtain reports on the integration of technology into the learning and teaching practise in schools, there have been, as far as it could be ascertained, only instruments designed overseas to determine such integration. As a result of a peculiar situation in schools and institutions in South Africa, not a single one of these instruments was suitable and appropriate for use in the investigation in question. It was then decided to construct a distinctive questionnaire, which could be used to measure how schools have integrated technology into their learning and teaching practice within the context of South African schools.

To develop the questionnaire, principals and school governing bodies were requested for permission to meet at least a computer manager, a principal and a computer literate educator from each school. The computer managers, principals and educators were requested to give at least one item which they thought could contribute in assisting learners be effective computer users in

their learning at schools. They were also asked if their schools had developed strategic policies to assist learners to be computer literate.

Computer managers and educators wrote down the items on a piece of paper. Valuable contributions of two hundred and thirty (230) items were received and related to the salient points from the review of the literature (pre-figured foci) and themes that emerged from the research itself (emergent foci) (Shank, 2002:33) to construct preliminary questions as efficaciously as possible. These items were used to construct the first draft of the questionnaire. Those items, which overlapped and were ambiguous were eliminated.

An effort was made to have all the items included in the questionnaire to fall within the comprehension level of all participants. The questionnaire was subdivided into the following sections:

- demographic data which formed Section A; and
- the effectiveness of principals, educators and computer managers in assisting learners to be computer literate.

3.6.1 The first draft of the questionnaire

In Section A of the questionnaire it was necessary to investigate some demographic particulars of the respondents like the type of school, where it is located, enrolment of learners at the school, teaching designation, the level of education of the respondents, number of computers in these schools, grades that use computers and the number of computer managers in these schools. Such information would help the investigation to ascertain whether:

- the size of a school could contribute to educators' ineffectiveness in assisting learners to be computer literate; and
- the level of education of members of the principals, educators and computer managers could contribute to their effectiveness in assisting learners to be computer literate.

From the literature survey, it was found that the effective process of integrating technology into the learning and teaching practice in schools depends on whether:

- computer technology is infused in lessons (see 1.1; 2.2.2; 2.16);
- parents and communities are mobilized in an effort to have a computer for every learner (see 1.1); and
- policies have been developed, adopted and implemented for the integration of computer technology into the school curriculum (see 2.8).

It was therefore necessary to include items related to all the above aspects in the questionnaire and they formed Section B of the questionnaire (see Addendum A).

3.6.2 Second draft of the questionnaire

The first draft of the questionnaire was discussed with the study supervisor and after additional modifications were made the second draft which contained 5 sections with 29 items was constructed (see Addendum A). The questionnaire was piloted in a number of primary and secondary schools in the township, in town and farm schools. This was done to:

- test if the English language used in constructing the questionnaire was clear and without unnecessary ambiguities; and
- investigate if there was a need to translate the questionnaire into other languages.

The results of the pilot study revealed the necessity for only slight technical modifications for the final draft and there was no need for the translation of the language used because all participants could read and understand English. Approval from the D7 and D8 Districts of Education in Gauteng was obtained to have the questionnaire filled in by principals, educators and computer managers in the 18 targeted schools.

3.6.3 Statistical techniques

Data was processed using the SPSS programme in consultation with the Statistical Consultation Services of the North-West University (Vaal Triangle Campus) in which the computer programme performed the TEST procedure of the SPSS System for Windows Release 2000.

3.7 CONCLUSION

In this chapter the research design process was discussed. The next chapter provides the analysis and interpretation of data collected during empirical research.

CHAPTER FOUR

ANALYSES AND INTERPRETATION

4.1 INTRODUCTION

In this chapter, the researcher analyses of data collected by means of questionnaires will be analysed by means of graphs. This data was received through the responses of the participants (N=370) who formed the sample of this research.

Data collected by means of interviews will be analysed and interpreted by means of themes.

The demographic data is analysed and interpreted first

4.2 SECTION A: DEMOGRAPHIC INFORMATION OF THE RESPONDENTS

This section provides the demographic information of the participants who formed sample of this research

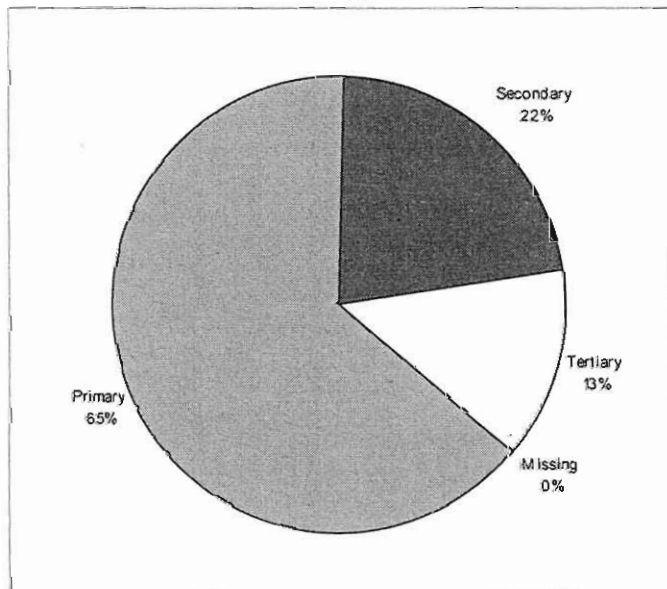


Figure 4.1: Type of school

Analysis and Interpretation

Of the respondents, 65% indicated that they teach in primary schools, 25% teach in secondary schools while 13% teach in tertiary institutions. This means that the population sample of this research consisted mainly of the participants from the primary schools.

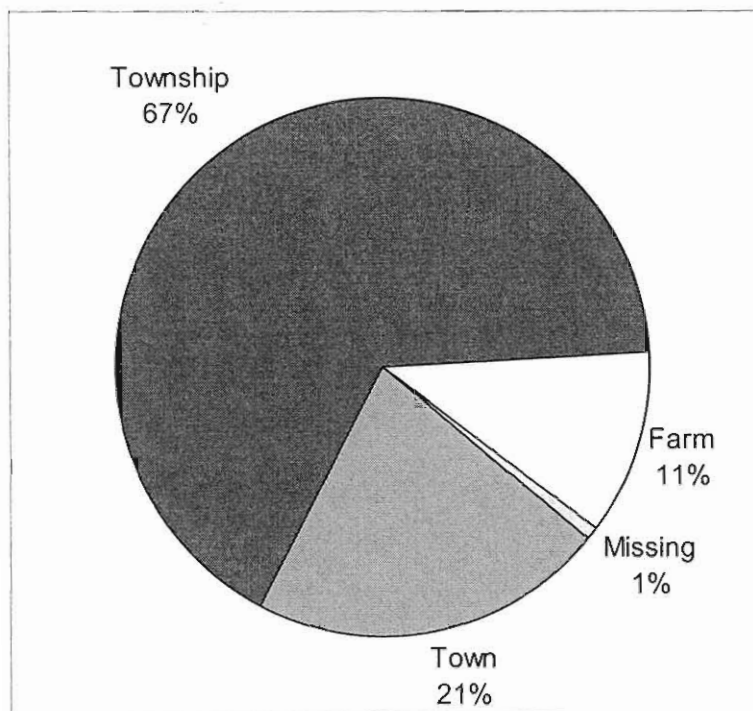


Figure 4.2: Location of schools

Analysis and interpretation

Of the respondents, 67% indicated that they teach in schools located in the townships, 21% indicated that they are in schools situated in towns, and 11% indicated that they are teaching at schools situated on farms. This means that the population sample of this research consisted mainly of the participants from townships schools.

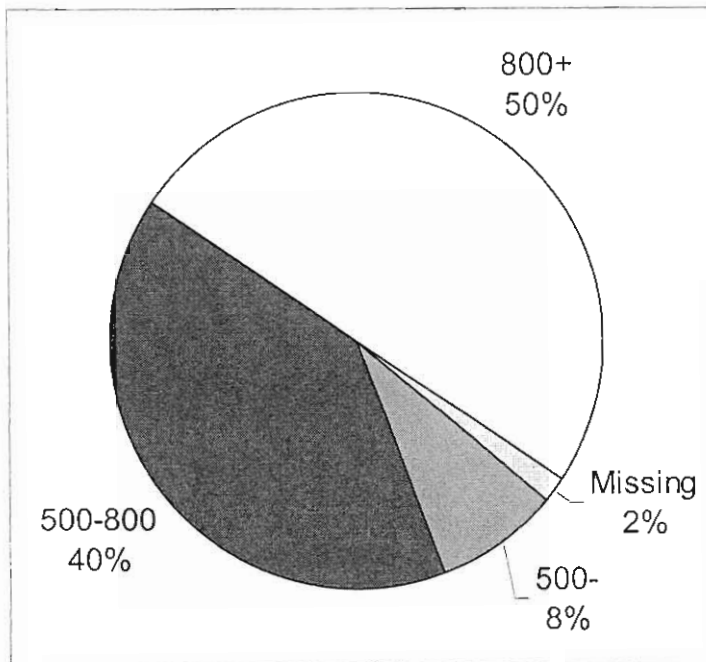


Figure 4.3: Enrolment

Analysis and Interpretation

50% of the respondents indicated that the enrolment of their schools is more than 800, 40% indicated that their enrolment is between 500 and 800, and only 8% indicated that their enrolment is less than 500. This means that the population sample of this research consisted mainly of the participants from big schools

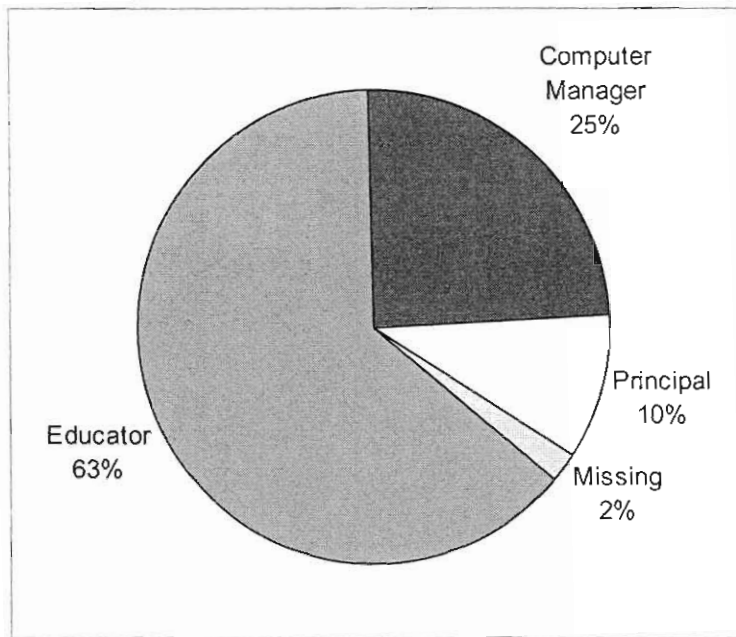


Figure 4.4: Teaching designation

Analysis and Interpretation

The respondents indicated that 65% of them are educators, 25% are computer managers, and only 10% are principals. This means that the population sample of this research consisted mainly of educators on post level one.

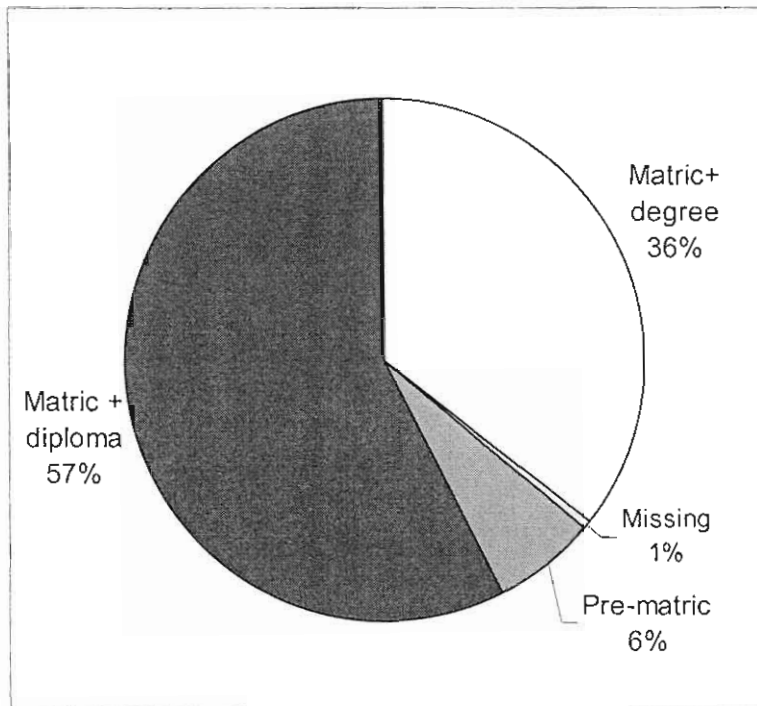


Figure 4.5: Level of education

Analysis and interpretation

Of the respondents, 57% indicated that they have matric and a diploma, 36% have matric and a degree and 6% do not have matric. This means that the population sample of this research consisted mainly of the participants who are on REQV 13, in terms of South African professional rating, that is to say, they have matric and a teaching diploma of three years.

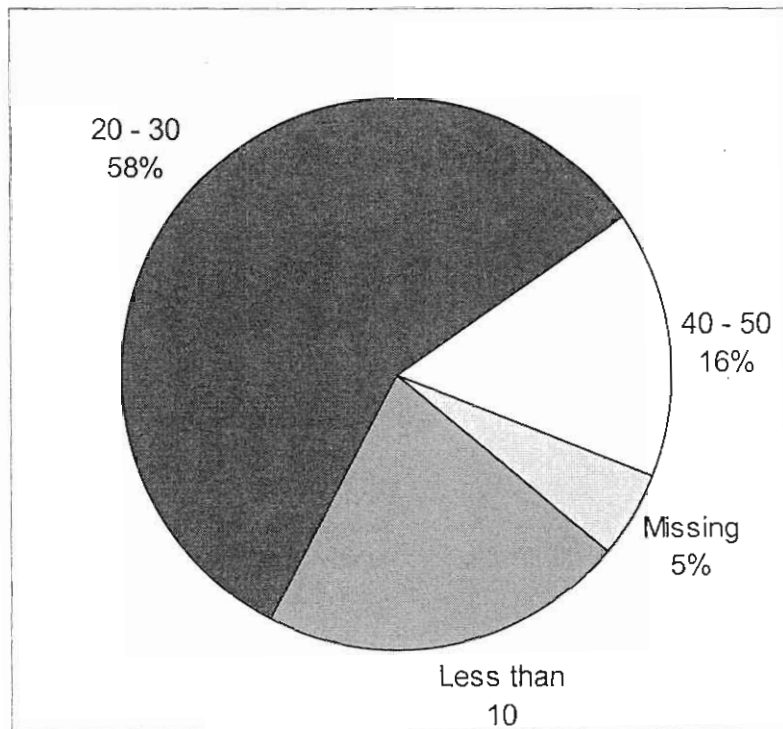


Figure 4.6: Number of computers

Analysis and interpretation

58% of the respondents indicated that they have 20-30 computers, 16% have 40-50 computers and only 21% 10 computers in their schools. This means that the population sample of this research consisted mainly of the participants were from schools with fewer computers. This could indicate that the computer laboratories of most schools in the Vaal Triangle area of the Gauteng Province do not have enough number of computers to promote computer literacy at all schools.

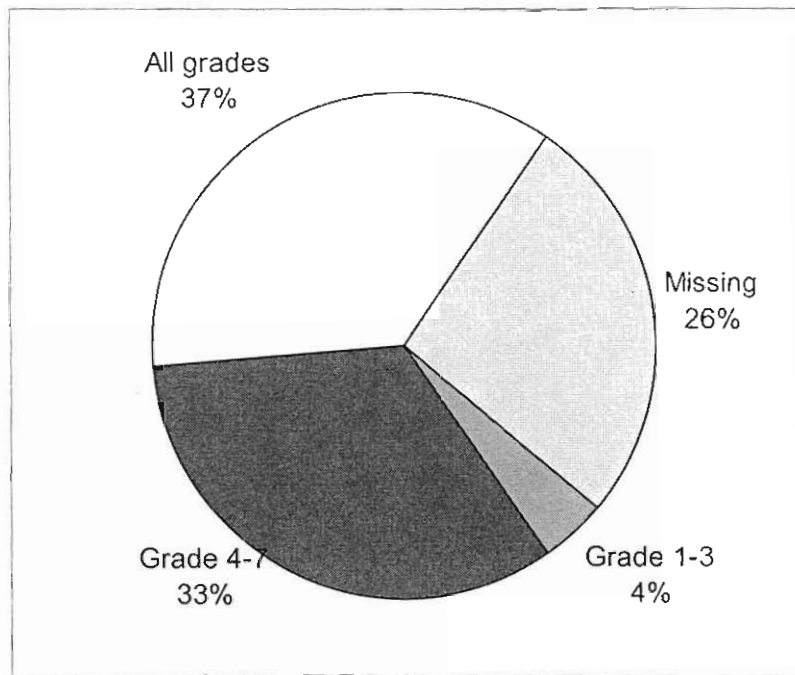


Figure 4.7: Grades that use computers

Analysis and Interpretation

37% of the respondents indicated that all grades in their schools use computers, 33% indicated that only grades 4-7 use computers, and four per cent indicated that only grades 1-3 use computers in their schools. This could mean that the population sample of this research consisted mainly of the participants where the provision for computer use is for all grades.

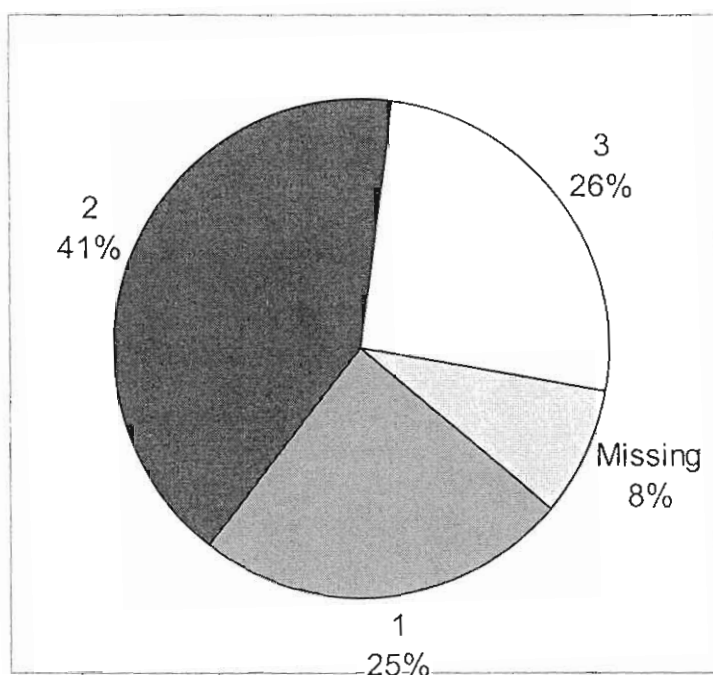


Figure 4.8: Number of computer managers

Analysis and Interpretation

Of the respondents, 41% indicated that they have two computer managers; 26% indicated that they have three computer managers, and 20% have only one computer manager in their schools. This means that the population sample of this research consisted mainly of the participants from schools with two computer managers, which bodes well for the efficient and effective management of information and communication technology in schools.

4.3 SECTION B: TECHNOLOGY INTEGRATION INTO LEARNING

It was necessary to test the extent schools' vision of learning incorporate technology. This section graphically analyses and interpretes the responses of participants on the way in which schools infuse technology in their teaching and learning settings (see research aim 2).

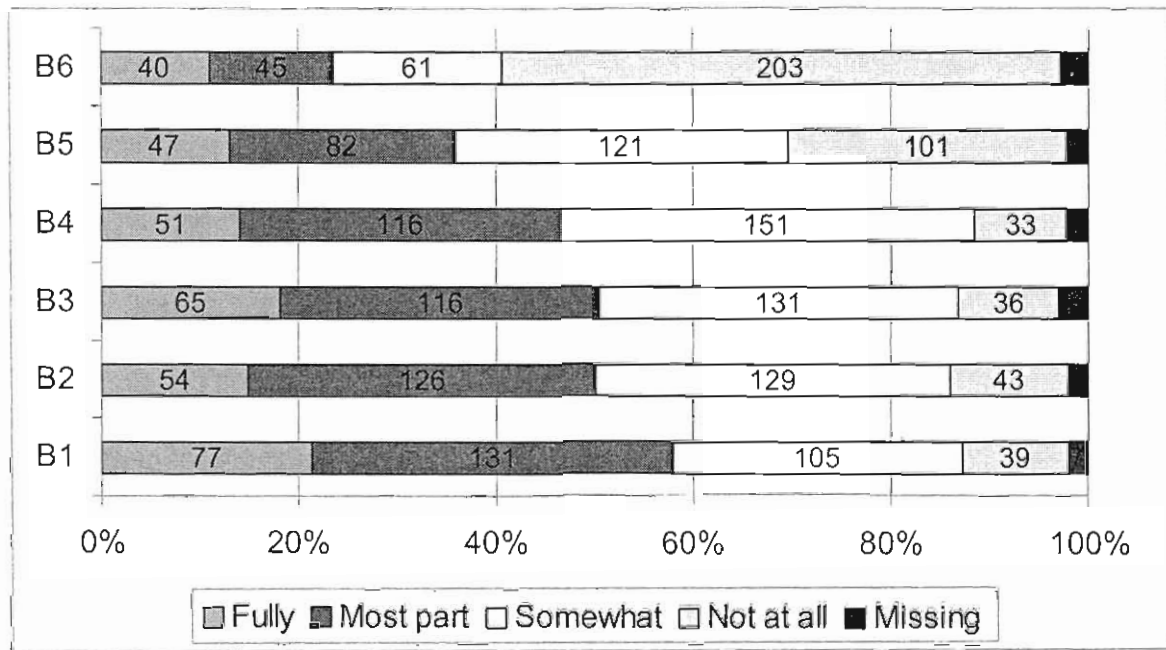


Figure 4.9: Infusion of technology

Analysis and interpretation

B1: The purpose of this question was to find out the extent to which schools have clearly articulated a vision of learning that incorporates key precepts of education transformation. For this question:

- 37% of the respondents indicated that their schools for the most part clearly articulated a vision of learning that incorporates key precepts of education transformation;
- 30% indicated that their schools partially (somewhat) articulated a vision of learning that incorporates key precepts of education transformation;
- 22% indicated that their schools fully articulated a vision of learning that incorporates key precepts of education transformation; and
- 11% indicated that their schools had not articulated a vision of learning that incorporates key precepts of education transformation at all.

The finding in this item of the questionnaire highlights that most schools do not articulate a vision of learning that incorporates key precepts of education

transformation. One would have expected an overwhelming positive and affirming response from participants especially that the twenty-first century is information and communication technology driven.

B2: The purpose of this question was to find out the extent that the schools vision of learning incorporates technology as a key component that can promote a challenging curriculum, and instructional practices that engage learners (e.g. collaborative learning, problem-based learning and project-based learning). For this question;

- 37% of the respondents indicated that their schools' vision of learning incorporates technology to some extent as a key component that can promote a challenging curriculum and instructional practices that engage learners;
- 36% indicated that for the most part their school's vision of learning incorporates technology as a key component that can promote a challenging curriculum and instructional practices that engage learners;
- 15% indicated that their schools' vision of learning fully incorporates technology as a key component that can promote a challenging curriculum and instructional practices that engage learners; and
- only 12% indicated that the vision of learning does not at all incorporate technology as a key component that can promote a challenging curriculum and instructional practices that engage learners.

The finding in this item of the questionnaire, again, highlights that very few of these schools vision of learning incorporates technology as a key component that can promote a challenging curriculum and instructional practices that engage learners. One would have expected an overwhelming positive and affirming response from participants especially that the South African schools' Curriculum 2005 is outcomes-based and promotes collaborative and team learning.

B3: The purpose of this question was to find out the extent the school's vision of learning emphasise technology-related research projects as a solution to real-world problems. For this question:

- 38% of the respondents indicated that their school's vision of learning emphasise technology -related research projects and the solution to real world problems to some extent;
- 33% indicated that for the most part their school's vision of learning emphasise technology-related research projects and the solution to real-world problems;
- 19% indicated that their school's vision of learning fully emphasise technology-related research projects as a solution to real-world problems; and
- 10% indicated that their school's vision of learning do not emphasise technology-related research projects as a solution to real-world problems.

The finding in this item of the questionnaire, again, highlights that schools do not fully emphasise technology -related research projects as a solution to real-world problems. A computer is an immensely powerful educational tool with a networking potential and access of knowledge and information (see 2.6.1).

B4: The purpose of this question was to find out the extent educators, principals and other key staff members understand their unique roles in this vision of learning and agree that technology needs to continue to be developed as a key to change instruction and learning. For this question:

- 43% indicated that educators, principals, and other key staff members partially understand their unique roles in this vision of learning and agree that technology needs to continue to be developed as as key tool to change instruction and learning;
- 33% indicated that for the most part educators, principals, and other key staff members fully understand their unique roles in this vision of learning

and agree that technology needs to continue to be developed as a key tool to change instruction and learning;

- 15% indicated that educators, principals, and other key staff members fully understand their unique roles in this vision of learning and agree that technology needs to continue to be developed as a key tool to change instruction and learning; and
- 9% educators, principals, and other key staff members do not at all understand their unique roles in this vision of learning and that technology needs to continue to be developed as a key tool to change instruction and learning.

The findings in this item of the questionnaire highlight that most principals educators and other key staff members partially understand their unique roles in this vision of learning and agree that technology needs to continue to be developed as as key tool to change instruction and learning. One would have expected an overwhelming positive and affirming response from principals and educators of the twenty-first century and professionals who operate in an outcomes-based teaching and learning situation.

B5: The purpose of this question was to find out the extent that the schools' vision of learning consider the needs of learners who are disadvantaged because of their socio-economic status or other variables that may place them at risk of school failure. For this question:

- 34% indicated that their school's vision of learning to some extent consider the needs of learners disadvantaged, because of their socio-economic status or other variables that may place them at risk of school failure;
- 30% indicated that their school's vision of learning had not at all consider the needs of learners disadvantaged by their socio-economic status or other variables that may place them at risk of school failure;
- 23% indicated that their school's vision of learning for the most part consider the needs of learners disadvantaged because of their socio-

economic status or other variables that may place them at risk of school failure; and

- Only 13% indicated that their school's vision of learning fully consider the needs of learners disadvantaged by their socio-economic status or other variables that may place them at risk of school failure.

The finding in this item of the questionnaire highlights that only a small percentage of the participants indicated that their school's vision of learning fully consider the needs of learners disadvantaged by their socio-economic status or other variables that may place them at risk of school failure. There is a need for schools to take the circumstantial situation of learners from disadvantaged families who may not have exposure to computers because parents/guardians cannot afford to buy them, and consequently they may not have regular practice and use at homes. One would have expected an overwhelming positive and affirming response from participants especially that the South African communities are still made of the majority of learners from disadvantaged families and also the high cognitive demands of Curriculum 2005 with its self-regulated learning approach.

B6: The purpose of this question was to find out the extent that the school's vision of learning promotes equity as they consider new uses of technology. For this question:

- 58% of the respondents indicated that their school's vision of learning does not at all promote equity as they consider new uses of technology;
- 17% that their school's vision of learning fully promotes equity as they consider new uses of technology;
- while 13% indicated that their school's vision of learning for the most part promotes equity as they consider new uses of technology; and
- only 12% indicated that their school's vision of learning fully promotes equity as they consider new uses of technology.

The finding in this item of the questionnaire, highlights that most schools' vision of learning does not promote equity as these schools consider new uses of technology. To promote equity would include equal access by both boys and girls, those that are physically challenged and all school learners within the school. In an outcomes-based curriculum equitable distribution of computers is imperative for effective development of learners.

4.4 SECTION C: TECHNOLOGY INTEGRATION FOR EDUCATORS' PROFESSIONAL DEVELOPMENT

It was necessary to test the extent of professional development and technological support of educators in schools. This section graphically analyses and interpretes the responses of participants on the way in which professional development and technological support of educators is operationalized at their schools (see research aim 3).

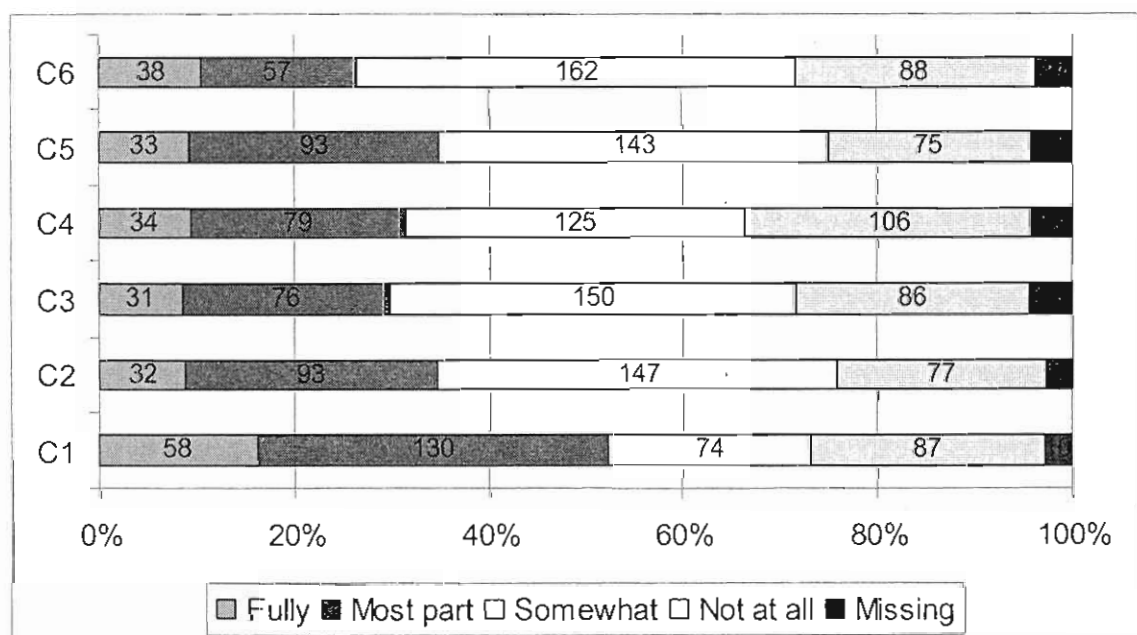


Figure 4.10: Professional development and technological support (See 2.17)

CI: The purpose of this question was to find out the extent the schools have developed a professional development plan that addresses the skills educators will need to integrate technology into the curriculum. For this question:

- 37% of the respondents indicated that their schools for most part developed a professional development plan that addresses the skills educators will need to integrate technology into the curriculum;
- 30% indicated that their schools had not at all developed a professional development plan that addresses the skills educators will need to integrate technology into the curriculum;
- while 21% indicated that their schools had to some extent developed a professional development plan that addresses the skills educators will need to integrate technology into the curriculum; and
- only 17% indicated that their schools fully developed a professional development plan that addresses the skills educators will need to integrate technology into the curriculum.

A very small percentage of the respondents indicated that their schools fully developed a professional development plan that addresses the skills educators will need to integrate technology into the curriculum. While educators may well be able to use and even teach with computers on a personal or individual basis, they lack the knowledge and skills needed to incorporate computer technology on a classroom-wide basis (see 2.2.2). Along the same lines, if these schools have not fully developed a professional development plan that addresses skills educators will need, there could be substantial lack of both pre- and post-service training and development courses, aimed at explaining how to integrate computers into instruction in any regularized manner, as well as acquiring computer skills. It is imperative for educators to be trained to use the technology and to apply it instructionally within their particular curriculum.

C2: The purpose of this question was to find out the extent the schools have budgeted sufficient monies for professional development and support for educators and instructional staff that will increase both their knowledge base about technology and their understanding of authentic learning. For this question:

- of the respondents, 42% indicated that their schools to some extent budgeted sufficient monies for professional development and support for educators and instructional staff that will increase both their knowledge base about technology and their understanding of authentic learning;
- 27% indicated that their schools for the most part budgeted sufficient monies for professional development and support for educators and instructional staff that will increase both their knowledge base about technology and their understanding of authentic learning;
- 22% indicated that their schools had not at all budgeted sufficient monies for professional development and support for educators and instructional staff that will increase both their knowledge base about technology and their understanding of authentic learning; and
- only 9% indicated that their schools fully budgeted sufficient monies for professional development and support for educators and instructional staff that will increase both their knowledge base about technology and their understanding of authentic learning.

A very small percentage of the respondents indicated that their schools fully budgeted sufficient monies for professional development and support for educators and instructional staff that will increase both their knowledge base about technology and their understanding of authentic learning. This finding highlights the need for schools to concertedly engage on a proactive plan both financially and developmentally to help educators integrate technology into the school curriculum. One would have expected an overwhelming positive response on proactive budgeting for information technology promotion at schools, especially during this twenty-first century, which is technology driven.

C3: The purpose of this question was to find out the extent the schools projected monies for professional development and technological support for school staff over a sufficient time period (e.g. five years). For this question:

- 44% of the respondents indicated that their schools to some extent projected monies for professional development and technological support for school staff over a sufficient time period;
- 25% indicated that their schools had not at all projected monies for professional development and technological support for school staff over a sufficient time period;
- 22% indicated that their schools for the most part projected monies for professional development and technological support for school staff over a sufficient time period; and
- only 9% indicated their schools fully projected monies for professional development and technological support for school staff over sufficient time period.

This finding highlights that the majority of the respondents' schools to some extent projected monies for professional development and technological support for school staff over a sufficient time period. There is a need for schools to concertedly engage on a proactive plan both financially and developmentally to train and capacitate educators in the integration of computer technology into the school curriculum. One would have expected an overwhelming positive response on proactive budgeting for information technology training for educators at schools, especially during this twenty-first century, where teaching and learning are technology driven.

C4: The purpose of this question was to find out the extent school governing body members and community members understand and support the educators' professional development plan and its budget. For this question:

- 36% of the respondents indicated that their schools' governing body members partially understand and support a professional development plan and its budget;

- while 31% indicated that their school governing body members and community members do not at all understand and support a professional development plan and its budget;
- 23% indicated that their school governing body members and community members for most part understand and support a professional development plan and its budget; and
- only 10% of the respondents indicated that their school governing body members and community members fully understand and support a professional development plan and its budget.

The majority of the respondents indicated that their schools' governing body members partially understand and support a professional development plan and its budget. This finding highlights the need for schools to ecosystematically engage with school governing bodies and other community agencies, which specialise on information technology and communication in order to integrate information technology into the curriculum.

C5: The purpose of this question was to find out the extent that educators, principals and other staff have been able to make an input into determining the type, content and length of professional development necessary to integrate technology throughout their instruction. For this question:

- 42% of the respondents indicated that educators, principals and other staff have, to some extent, been able to make an input into determining the type, content, and length of professional development necessary to integrate technology through out their instruction;
- while 27% indicated that educators, principals, and other staff for the most part have been able to make an input into determining the type, content, and length of professional development necessary to integrate technology through out their instruction;
- 22% indicated that educators, principals and other staff have not been able to make an input at all into determining the type, content, and length of

professional development necessary to integrate technology through out their instruction; and

- only 10% indicated that educators, principals and other staff have been able to fully make an input into determining the type, content, and length of professional development necessary to integrate technology through out their instruction.

A very small percentage of the respondents indicated that educators, principals and other staff have been able to fully make an input into determining the type, content, and length of professional development necessary to integrate technology through out their instruction. This finding highlights the need for schools to concertedly engage educators, principals and other staff to fully make an input into determining the type, content, and length of professional development necessary to integrate technology throughout their teaching activities.

C6: The purpose of this question was to find out the extent the schools' professional development plan addresses how technology can accelerate and enhance learning for the special needs of learners (e.g. economically disadvantaged). For this question:

- 27% of the respondents indicated that their schools' professional development plan partly addressed how technology can accelerate and enhance learning for learners with special needs;
- while 26% indicated that their schools' professional development plan did not at all address how technology can accelerate and enhance learning for learners with special needs;
- 17% indicated that their schools' professional development plan for the most part addressed how technology can accelerate and enhance learning for learners with special needs; and

- only 11% indicated that their schools professional development plan fully addressed how technology can accelerate and enhance learning for learners with special needs.

Very few respondents indicated that their schools professional development plan fully addressed how technology can accelerate and enhance learning for learners with special needs. This finding highlights the need for schools to concertedly engage on a proactive plan both financially and developmentally to help learners with learning special needs. One would have expected an overwhelming positive response on proactive budgeting for information technology promotion at schools, even for learners with special learning needs, especially during this twenty-first century which is technology driven.

4.5 SECTION D: EQUITABLE ACCESSIBILITY OF TECHNOLOGY TO LEARNERS

It was necessary to test the extent schools provide equitable access of computers (see research aim 4). This section is formulated in such a way that the graph is presented first, then data is analysed and interpreted accordingly.

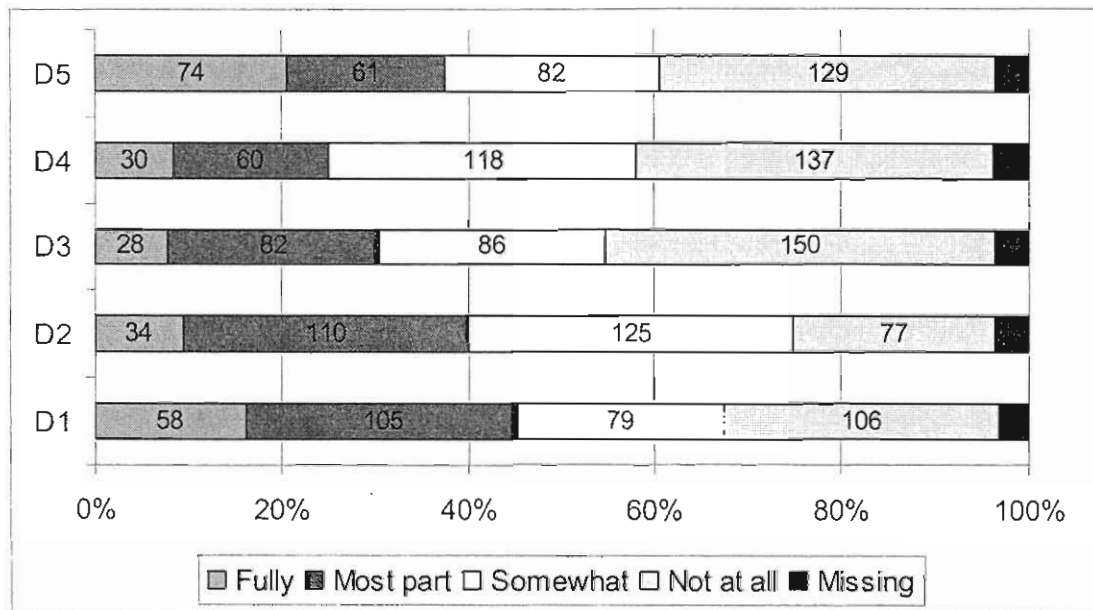


Figure 4.11: Technology and equity

D1: The purpose of this question was to find out the extent the schools' plans for technology ensure that computers will be placed in a combination of classroom and computer labs to ensure equitable access for all learners in all areas. For this question:

- 30% of the respondents indicated that their school's plans for technology for the most part ensured that computers will be placed in a combination of classroom and computer labs to ensure equitable access for all learners in all areas;
- while 30% indicated that their school's plans for technology does not at all ensure that computers will be placed in a combination of classroom and computer labs to ensure equitable access for all learners in all areas;
- 23% indicated that their school's plans for technology to some extent ensures that computers will be placed in a combination of classroom and computer labs to ensure equitable access for all learners in all areas; and
- only 17% of the respondents indicated that their school's plans for technology fully ensures that computers will be placed in a combination of

classroom and computer labs to ensure equitable access for all learners in all areas.

This finding highlights that the majority of the participants indicated that their school's plans for technology for the most part ensured that computers will be placed in a combination of classroom and computer labs to ensure equitable access for all learners in all areas. There need for schools to synergistically connect classrooms to computer laboratories for children to see that computer laboratories are linked to their classroom work, just like the libraries.

D2: The purpose of this question was to find out the extent the schools have changed methods of instruction to ensure that learners who typically experience less challenging content and remediation can use technology to engage with challenging ideas and the solution of real-world, relevant problems. For this question:

- of the respondents 36% indicated that their schools have to some extent changed methods of instruction to ensure that learners who typically experience less challenging content and remediation can use technology to engage with challenging ideas and the solution of real-world, relevant problems;
- while 32% indicated that their schools for the most part have changed methods of instruction to ensure that learners who typically experience less challenging content and remediation can use technology to engage with challenging ideas and the solution of real-world, relevant problems;
- 22% indicated that their schools have not at all changed methods of instruction to ensure that learners who typically experience less challenging content and remediation can use technology to engage with challenging ideas and the solution of real-world, relevant problems; and
- only 10% of the respondents indicated that their schools have fully changed methods of instruction to ensure that learners who typically experience less challenging content and remediation can use technology

to engage with challenging ideas and the solution of real-world, relevant problems.

The majority of the participants indicated that their schools have to some extent changed methods of instruction to ensure that learners who typically experience less challenging content and remediation can use technology to engage with challenging ideas and the solution of real-world, relevant problems. There need for schools to link information technology to remedial classes in order to help learners solve problems, which they encounter in their classroom didactics.

D3: The purpose of this question was to find out the extent the school governing body and community members have discussed and planned for school-initiated ways in which computers can be used at home on a contractual basis, with the school or district. For this question:

- 43% of the respondents indicated that their school's governing body and community members have never discussed and planned, with the school or district, for school-initiated ways in which computers can be used at home on a contractual basis;
- and 25% indicated that their school's governing body and community members have to some extent discussed and planned, with the school or district, for school-initiated ways in which computers can be used at home on a contractual basis;
- while 24% indicated that their school's governing body and community members have, for the most part, discussed and planned, with the school or district, for school-initiated ways in which computers can be used at home on a contractual basis; and
- only 8% of the respondents indicated that their school's governing body and community members have fully discussed and planned, with the school or district, for school-initiated ways in which computers can be used at home on a contractual basis.

The majority of the participants indicated that their school's governing body and community members have never discussed and planned, with the school or district, for school-initiated ways in which computers can be used at home on a contractual basis. This finding highlights the need for schools to develop contractual obligations with parents for learners to regularly take computers home for home-works and other self-regulated learning projects after school. The use of computers at home by learners would ensure parental involvement as these learners would also be assisted by their parents. This can also promote parental involvement in the integration of technology.

D4: The purpose of this question was to find out the extent the schools involved family and community members in discussions of computer technology and ways in which they can help their children at home and also learn important skills. For this question:

- 40% of the respondents indicated that their schools never involved family and community members in discussions of computer technology and ways in which they can help their children at home and also learn important skills;
- 34% indicated that their schools to some extent involved family and community members in discussions of computer technology and ways in which they can help their children at home and also learn important skills;
- while 17% indicated that their schools for the most part involved family and community members in discussions of computer technology and ways in which they can help their children at home and also learn important skills; and
- only 9% of the respondents indicated that their schools fully involved family and community members in discussions of computer technology and ways in which they can help their children at home and also learn important skills.

The majority of the participants indicated that their schools never involved family and community members in discussions of computer technology and

ways in which they can help their children at home and also learn important skills. This finding highlights the need for schools to involve family and community members in discussions of computer technology promotion at schools. Schools need school, family and community partnerships in order to promote effective computer technology in the school curriculum.

D5: The purpose of this question was to find out to what extent instruction is monitored to ensure that one group or gender does not dominate access. For this question:

- 37% of the respondents indicated that their school's instruction is not monitored at all to ensure that one group or gender does not dominate access;
- while 24% indicated that their school's instruction is to some extent monitored to ensure that one group or gender does not dominate access;
- 21% of the respondents indicated that their school's instruction is fully monitored to ensure that one group or gender does not dominate access; and
- only 18% indicated that their school's instruction for the most part is monitored to ensure that one group or gender does not dominate access.

The majority of the participants indicated that their school's instruction is not monitored at all to ensure that one group or gender does not dominate access. This finding highlights the need for schools to concertedly monitor instruction of computer technology in order to ensure that one group or gender does not dominate access to computer literacy. This is necessary to promote equitable distribution of technology skills and knowledge to both boys and girls.

4.6 SECTION E: AVAILABILITY OF TECHNOLOGY RESOURCES NECESSARY TO IMPLEMENT TECHNOLOGY

It was necessary to test the extent schools ensure for the provision of both human and physical resources necessary for the integration of technology into

the curriculum (see research aim 5). This section is formulated in such a way that the graph is presented first, then data is analysed and interpreted accordingly.

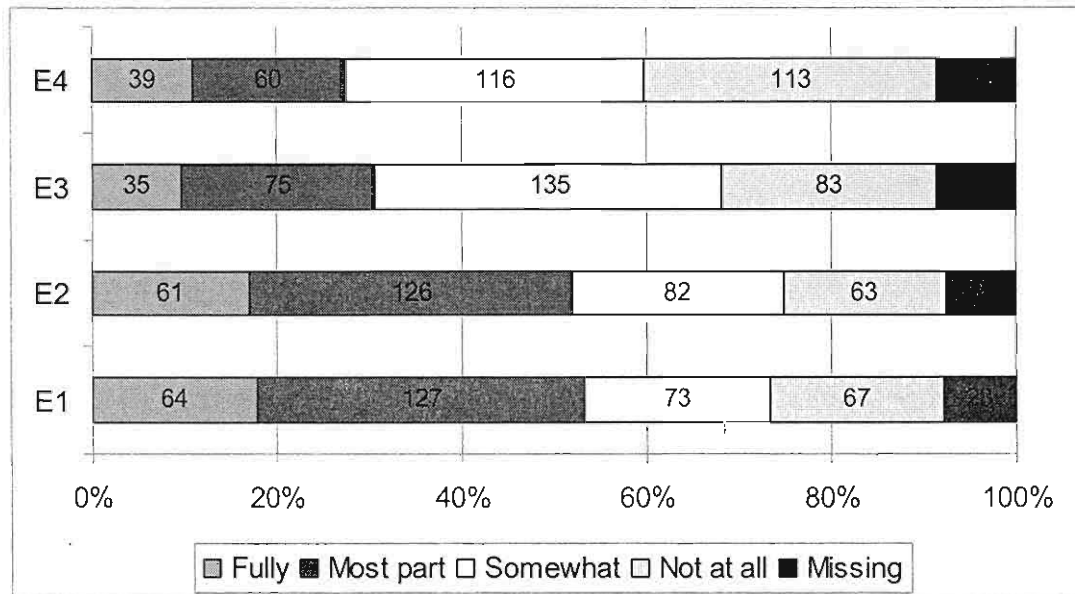


Figure 4.12: Technology and resources

E1: The purpose of this question was to find out the extent the school researched not only the amount of resources necessary to implement technology into the vision of learning but had also made plans to ensure that the school can acquire those resources. For this question:

- 38% of the respondents indicated that their schools had for the most part researched not only the amount of resources necessary to implement technology into the vision of learning and learning but had also made plans to ensure that the school can acquire those resources;
- 22% indicated that their schools had to some extent researched not only the amount of resources necessary to implement technology into the vision of learning and learning but had, to some extent, also made plans to ensure that the school can acquire those resources;
- 20% indicated that their schools had never researched not only the amount of resources necessary to implement technology into the vision of

learning and learning but neither had they made plans to ensure that the school can acquire those resources; and

- only 19% per cent indicated that their schools had fully researched not only the amount of resources necessary to implement technology into the vision of learning and learning but had also made plans to ensure that the school can acquire those resources.

The majority of the participants indicated that their schools had for the most part researched not only the amount of resources necessary to implement technology into the vision of learning and learning but had also made plans to ensure that the school can acquire those resources. This finding highlights the need for schools to fully engage on a research to find out the cost of resources necessary to implement technology into the vision of learning and teaching and also to make plans to ensure that schools acquire those resources.

E2: The purpose of this question was to find out the extent the schools' plan for technology ensures that all learners within the school use computers. For this question:

- 38% of the respondents indicated that their school's plan for technology for the most part ensures that all learners within the school use computers;
- 25% indicated that their school's plan for technology only partially ensures that all learners within the school use computers;
- 19% indicated that their school's plan for technology did not at all ensure that all learners within the school use computers; and
- only 18% indicated that their school's plan for technology fully ensures that all learners within the school use computers.

The majority of the participants indicated that their school's plan for technology for the most part ensures that all learners within the school use computers. This finding highlights the need for schools' plans for technology to ensure that all learners within the school use computers for both their

human resources' development and to prepare them for the twenty-first century world of work.

E3: The purpose of this question was to find out the extent the schools' budget for technology includes adequate personnel to support educators as they acquire necessary knowledge to integrate technology throughout their instruction. For this question:

- 41% indicated that their school's budget for technology only partly included adequate personnel to support educators as they acquire necessary knowledge to integrate technology through their instruction;
- while 25% indicated that their school's budget for technology did not include adequate personnel to support educators as they acquire necessary knowledge to integrate technology through their instruction;
- 23% indicated that their school's budget for technology for the most part included adequate personnel to support educators as they acquire necessary knowledge to integrate technology through their instruction; and
- only 11% indicated that their schools' budgets for technology fully include adequate personnel to support educators as they acquire necessary knowledge to integrate technology through their instruction.

The majority of the participants indicated that their school's budget for technology only partly included adequate personnel to support educators as they acquire necessary knowledge to integrate technology through their instruction. This finding highlights the need for schools' budgets for technology to include adequate personnel to support educators as they acquire necessary knowledge to integrate technology throughout their instruction.

E4: The purpose of this question was to find out the extent the schools' budget plans included incentives for educators who seek out and acquire additional resources in the form of grants or the other monies to support integration of technology into their instruction. For this question:

- 35% of the respondents indicated that their school's budget plans to some extent included incentives for educators who seek out and acquire additional resources in the form of grants or other monies to support the infusion of technology in their instruction;
- while 35% indicated that their school's budget plans did not include incentives for educators who seek out and acquire additional resources in the form of grants or other monies to support the infusion of technology in their instruction;
- 18% indicated that their school's budget plans for most part include incentives for educators who seek out and acquire additional resources in the form of grants or other monies to support the infusion of technology in their instruction; and
- only 12% of the respondents indicated that their school's budget plans fully includes incentives for educators who seek out and acquire additional resources in the form of grants or other monies to support the infusion of technology in their instruction.

Most participants indicated that their school's budget plans to some extent included incentives for educators who seek out and acquire additional resources in the form of grants or other monies to support the infusion of technology in their instruction. This finding highlights the need for schools' budget plans to include incentives for educators who seek out and acquire additional resources in the form of grants or the other monies to support the integration of technology into their instruction.

4.7 QUALITATIVE RESEARCH

In this section, responses of interviewees (n=10) are presented *verbatim* and interpreted by means of themes.

4.7.1 Individual interviews with educator participants

The responses of interviewees (n=10) from five schools in the Vaal Triangle are presented.

Interviewer: What does the phrase 'integration of technology into the classroom' mean to you?

Interviewee1: To me it means enabling the learners to use computers effectively. This means that learners and educators now have access to computers unlike before where we use to just tell learners what computers can do without showing them practically.

Interviewee 2: It is to use technology to improve learner's learning. It means blending technology with our daily tools of teaching and ensuring that they complement each other to enhance teaching and learning. This can be possible if learners are able to use computers in such a way that they are able to retrieve information on their own without the assistance of the educator. This could mean that for such an integration to succeed it would have to be learner-centred and not educator-centred.

Interviewee 3: It means to create an opportunity for technology to have a meaningful role in the enhancement of the learning process.

Interviewee 4: I believe that the integration of technology into the classroom is to enable learners to explore career opportunities. If learners are using computers effectively they can be able to access information on the careers they are interested in. They would grow up knowing exactly what their career choices pertains.

Interviewee 5: It is used to describe effective use of technology by educators. This could mean that educators would be able to plan lessons, facilitate and assess learners through the use of technology. All learning areas can be planned and facilitated through computers except for vernacular languages.

Interviewee 6: Integration of technology would mean access to computers where I can be able to use them whenever I have to. I do not think I would have fully integrated technology if I use it once or twice a month. Learners should get used to using computers in every lesson they are taught.

Interviewee 7: I think it is when we are able to allow all learners within the school to use computers from the lowest to the highest grade. There should be no discrimination. What I mean is that sometimes we say that learners in grade seven should be allocated more time than learners in grade one. This promotes inequality in the integration of technology. I think learners need to be given equal opportunities to use computers irrespective of their study grades.

Interviewee 8: To me it means to develop and nurture the critical abilities of learners within the school. It also means that learners are able to gather information on their own and that their inquisitive minds can be guided to explore. Giving them the opportunity to 'surf the net' would enable them to discover their talents. This however should be monitored and controlled so that by the end of the period learners are able to achieve outcomes.

Interviewee 9: It means using the technology to teach in different ways and also to allow students with different learning styles to learn more effectively. Learners can search for any text from the computer and read from it. This would be more interesting to learners as they are only used to reading from their books. Adoption of different learning styles will accommodate those that are under achieving and stimulate their interest in learning.

4.7.1.1 Theme 1: The integration of technology in the classroom means facilitation of effective learning and teaching, and offers learners opportunities to explore various careers.

Interviewer: How are you assisting your school with the integration of technology into the classroom?

Interviewee 1: I assist in developing timetables which is usually not properly done. This is due to the fact that one needs to be properly trained with regards to the drawing up of timetables. I also encourage educators to attend professional development technology sessions which usually take place only on Mondays at our school.

Interviewee 2: I do so by taking learners to the computer lab, letting them do some typing and by helping them find pictures relevant to a particular learning area. These could be pictures of nature such as animals and plants or pictures that deals with any other subject relevant to our lessons.

Interviewee 3: I always participate in the drafting of school technology policies and making rules known to educators as users of computers.

Interviewee 4: As a member of the LSM (Learners Support Material) I assist by facilitating equitable access to technology resources by all learners such as ink for the printer, papers as well as the cleaning and the maintenance of our computer lab.

Interviewee 5: I do so by attending technology workshops which are sometimes held here at school and are facilitated by an educator who has a better understanding of computers.

Interviewee 6: I offer learners an opportunity to demonstrate their knowledge and understanding of what has been learnt. Learners are also encouraged to find different definitions of words and later they get asked to make written presentation in the classroom on their understanding of such words.

Interviewee 7: I do so by developing lesson plans and by helping educators come up with ideas for using technology. This only applies to educators who have interest in the usage of technology.

Interviewee 8: During computer lessons, I make sure that learners are logged into the system and kept on task during class period.

Interviewee 9: I sometimes use my time helping individual learners with specific questions about their chosen websites, the use of computer hardware and software. I also provide support where necessary as they carry out performance tasks.

Interviewee 10: I offer motivation. I think it is something one needs. Motivation comes from the sense of control or self-determination. I believe

that a learner should learn in an empowering environment so that he/she becomes a problem solver.

4.7.1.2 Theme 2: The integration of technology into the curriculum demands planning abilities, organizational skills and empowerment of educators, including the empowerment of learners.

Interviewer: How is the integration of technology into the classroom being implemented in your school?

Interviewee1: I only follow the timetable. We go to the computer lab once every week during the technology period.

Interviewee 2: I usually take my learners to the computer lab. When learners are busy researching I mark books.

Interviewee 3: I sometimes go to the lab just to rest and look at my personal e-mails whilst learners are busy with their own research.

Interviewee 4: I never take my learners to the lab because I realized that it is time consuming for both me and the learners.

Interviewee 5: When I take my learners to the lab it is like my free period. I ask two learners who are familiar with computers to assist the others.

Interviewee 6: I only follow the timetable because we are obliged to and as a result I cannot make use of computers whenever I need to.

Interviewee 7: I am allowed to use my own discretion when it comes to the timetable. I have four technology periods per week. I use two periods for computer classes and the other two for teaching technology to my class.

Interviewee 8: We have two computer managers within the school. They decide which classes are to use the computer laboratory. Sometimes I take my class twice or thrice a month depending on the decision of the computer managers.

Interviewee 9: I cannot answer this question. We need to take into consideration that our schools are not the same. Maybe if we can be given an opportunity to visit other schools and classrooms to observe how technology is integrated into those schools then we can be able to indicate how we are doing in this regard. We might also need to meet with other educators to share ideas on using technology within different contexts.

Interviewee 10: It is not easy for me to integrate technology into the classroom because I am not computer literate. I can only log in, use Microsoft word and to check my email. This is all I can do. This makes it difficult for me to assist in integration because I am the one who need the assistance!!

4.7.1.3 Theme 3: Schools do not have a mandatory obligation to enforce the teaching of computer technology to their learners.

Ideally, how should integration of technology into the classroom be implemented?

Interviewee 1: In our school all the grade ones do not attend computer classes. We do not have a educator in those grades who is computer literate. In an ideal school a educator would be organized from other grades to take grade ones for computer classes but it is not happening in our school.

Interviewee 2: I am not sure of the ideal situation as the GOL (Gauteng On Line) did not train us on the integration of computers. All what it did was to offer us training on how to use the software and the hardware and these are just basic skills. We still need to be developed in integrating technology. There is no budget for technology in our school. If a keyboard is not working it is the responsibility of the school to see what to do. It takes a long time to repair anything that is broken as it is not in the budget.

Interviewee 3: We educators need to register for technology classes so as to become effective implementers of technology. It is important for me not to rely entirely on what we were taught by GOL because integration is not about technology. It is primarily about content and effective instructional practices. We are not equipped to teach using computers all what we can teach our

learners is keyboarding for typing, micro-soft word for writing assignments and finding pictures on picture clips that are relevant to the topic.

Interviewee 4: Nobody seems to know what integration of technology is all about. It is somehow complicated. We have access to computers as we have about twenty-five computers within the school but where do I begin to integrate technology. I do not have a problem with taking my learners to the computer lab but the problem is about what do once I am there with them. I do not know what to teach them. I have been teaching for about twenty years without using computers now I have to teach everything through a computer, I still have to be taught myself before I can be able to teach learners.

Interviewee 5: In our school we have not received any GOL policies we have only received circulars on the workshops for GOL. I think it would be ideal to give learners progress reports on computer lessons. In our school we are far from doing this as we have not even started planning for computer classes. It will be difficult then to evaluate what we do as it is currently haphazard. What I mean is that we just do anything that comes to mind on a particular day.

Interviewee 6: An ideal situation would be to use computers whenever we need them. We do not have computers in our classrooms as such we have to take a 'trip' to the lab when we have to use computers. We cannot just do this whenever we feel like as according to the timetable we have to go once a week to accommodate other classes.

Interviewee 7: To me an ideal situation would be when all educators see the need to integrate technology. We still have a lot of educators in our school who regard taking learners to the lab as an unnecessary and a futile exercise.

Interviewee 8: I think we are not yet ready to integrate technology in our schools. We do have educators who have Computer Based Education but we do not approach them to workshop us as a school. The schools are not using the resources at their disposal. These people should be sharing their skills with the rest of the staff but because we are so naïve we cannot learn from them.

Interviewee 9: We are not able to be effective in integrating technology. The number of computers that we have is not enough. We have fifty learners in our classes two learners have to share a computer. This means that it is impossible for them to do individual exercises as they always have to work in pairs.

Interviewee 10: Computer lessons are not monitored or controlled by the School Management Team. This lack of monitoring and control makes us as educators to see that there is no point in doing what is not going to be monitored or checked. What they do is to check work done by learners in their books, so instead of concentrating on computer lessons I have to do more class work so that they find work in learners' books:

4.7.1.4 Theme 4: Educators lack computer technology skills and there is an element of mandatory educational management policies on the integration of computer technology into the teaching and learning situation.

Interviewer: As a teaching practitioner, which professional development activities do you think might facilitate the integration of technology into the classroom?

Interviewee 1: The ability to use spreadsheet in Microsoft excel can assist learners who are struggling to do their calculations. This is a very useful tool for exploring the number concepts and mathematical relationships. Educators who teach Mathematics would be more effective in the integration of technology if they would use this tool.

Interviewee 2: Educators need to be developed in the use of PowerPoint in order to present lessons through slides and pictures.

Interviewee 3: Word processor is an important tool which needs more attention. I have discovered that if learners use word processor for their assignments they are better able to actively engage in the learning process and are also exposed to more resources such as thesaurus, picture images and many more which they can use to assist them.

Interviewee 4: Key boarding. I have realized that most educators, including myself need to be taught keyboarding as a skill so that one can use a computer keyboard efficiently and effectively.

Interviewee 5: As an English educator I honestly wish that I could conduct reading lessons in the computer laboratory. Professional development would enable us as educators to guide learners in developing their own reading of books using technology.

Interviewee 6: To me it is important to be developed in data manipulation. This will help educators to search for information on the internet so that they and the learners can be able to solve problems as they arise.

Interviewee 7: I can only be able to facilitate the integration of computers if I am computer literate. I still need to be developed in basic computer skills.

Interviewee 8: Creating of charts and plotting graphs are the most important things that one needs to learn for both languages and Mathematics.

Interviewee 9: I usually assist with administration tasks, designing assessment record sheets, keeping learners' records, word processing and typing of exam papers.

Interviewee 10: Application of database. To me database is an ideal tool for educators and learners to gather and arrange data. It also serves as a guide for both educators and learners in solving their problems.

4.7.1.5 Theme 5: Computer technology in all computer programmes is necessary if educators are to be successful and competent in effective teaching of learners

Interviewer: In your opinion, which factors do you think prevent/inhibit the implementation of integration of technology into the classroom?

Interviewee1: As educators we need greater amount of time to learn how to use new software and in integrating technology into classroom practices. We

were trained for two weeks and I feel that we need more time to practice. There is no time to do integration because there is a lot of work to do.

Interviewee 2: Lack of training inhibits integration and educators' use of technology. We were only trained once in 2005. There has never been a follow up on how we implement the skills we gained at that training. I think we should have these trainings more often.

Interviewee 3: Lack of knowledge in the integration of educational software that provides opportunities for learners to improve their learning e.g. in Maths and Science.

Interviewee 4: We are not familiar with the terminology used in technology. It is difficult for us even to understand the difference between hardware and software. If we do not know these terms ourselves how can we teach them to learners?

Interviewee 5: Educator attitude have a significant influence on one's computer implementation behaviour in the classroom. I personally feel that it is a waste of time. Learners can be taught computers at home by their parents. I have to carry on with the learning programme so as to be able to finish it by the end of the year.

Interviewee 6: Another inhibiting factor is access to resources which means sufficient technology infrastructure must be made available for successful technology use.

Interviewee 7: For most of the experienced classroom educators, which I am part of it is difficult to implement technology because we regard it as time consuming.

Interviewee 8: Training is also a contributing factor because I only attended a one-week computer training which was of no benefit to me with regards to exposure of technology integration in the content area.

Interviewee 9: Lack of knowledge concerning how to do lesson plans and conduct lessons using a computer.

Interviewee 10: Educators have a tendency to resist change. Something new is always regarded as being unnecessary, unimportant, time consuming etc.

4.7.1.6 Theme 6: There is a great need for an intensive training of educators on computer technology and the various softwares which are available for educators in various learning areas.

Interviewer: As a teaching practitioner what do you believe is the role of instructional technology in education?

Interviewee1: I believe that it should transform the role of the educator into that of a facilitator or an academic coach who engages and empowers learners.

Interviewee 2: To me I think it provides the learners with the opportunity to make real life connection with the learning material.

Interviewee 3: Well, I'm not sure exactly what to say, but I actually think that it enables learners to know how to display video, use colour and print font sizes which are all very important.

Interviewee 4: I spend my time in the computer laboratory where I have seen the role of instructional technology allowing learners to actually revisit and rethink ideas.

Interviewee 5: Transforms the role of the educator by placing them as facilitators.

Interviewee 6: It provides educators with the opportunity to find new ways of helping learners to learn effectively.

Interviewee 7: I think it improves learners' critical thinking, problem solving and promotes independent discovery.

Interviewee 8: It draws or grabs and keeps learners' attention as the instructor brings information to life.

Interviewee 9: It is to enable learners to get the skills and knowledge they need.

Interviewee 10: I think it provides the learners with the opportunity to participate in skill-based activities such as drawing, typing and research gathering.

4.7.1.7 Theme 7: Integrating computer technology into the curriculum during this social constructivist period in South Africa necessitates facilitation skills which develop learners' critical thinking skills, including drawing, typing and research skills.

Interviewer: How do you use a computer for your personal and or professional work?

Interviewee1: I personally use a computer to keep records of learners like class list, assessment records and to search for information.

Interviewee 2: I sometimes go to computer lab just to play games and listen to music which is what I enjoy doing.

Interviewee 3: I use a computer to keep my personal files, to read my emails and to search for information using search engines such as Yahoo and Google.

Interviewee 4: I use it to access sources of leisure such as online games and searching for educational policies.

Interviewee 5: As a secretary in the committee I normally use it to write minutes and letters to parents in an event I need to discuss something with them.

Interviewee 6: I always prepare my lessons using a computer though it's time consuming because I struggle with keyboard all the time.

Interviewee 7: I only use a computer for cut, copy, paste and setting of tests.

Interviewee 8: I use a computer to look for pictures and images related to a particular lesson in class, for example, if I am treating water pollution I will find pictures related to it and print them.

Interviewee 9: I use it for designing worksheets; working on the Internet and to seek information for my own assignments.

Interviewee 10: I use it for creating and editing letters to parent, save my documents to a folder and to check spellings in grammar or even to correct typing mistakes

4.7.1.8 Theme 8: Computer technology also has capacity to enhance educators' efficient and effective school, class and learning area administration, including their personal professional development.

Interviewer: In your opinion which factors enhance the implementation of integration of technology into the classroom?

Interviewee 1: I think educators should be encouraged to implement integration of technology. This is the responsibility of the School Management Teams (SMTs).

Interviewee 2: The school management should organize workshops for educators. There are educators who cannot even log on. If they know how to use a computer they would be motivated to use it in their teaching.

Interviewee 3: Having computer specialists in all schools would help. We do not have these specialists in our schools as we did not budget for their salary this financial year. These specialists support educators in the implementation of technology integration. In schools where educators are computer literate learners do not suffer as they all get opportunities and support they need.

Interviewee 4: I think that there should be incentives for educators. Educators should be awarded for implementing technology. The school can raise funds for awards and/or for the payment of educators who workshop others.

Interviewee 5: I think that the department of education should provide for financial support to schools for them to have educators attend in-service training.

Interviewee 6: School Management Teams can develop school-based policies for technology integration. If there are no policies nothing will guide the school in the effective implementation process. Educators would know what is expected of them if there are policy guidelines.

Interviewee 7: Willingness to learn on the side of educators would enhance effective implementation. Most educators at our school are not willing to learn they are satisfied with just saying that they do not know.

Interviewee 8: Continuous use of computers would enhance implementation of technology integration in schools. It is however not possible in our school as we have 18 big classes which are sharing 25 computers.

Interviewee 9: Time-table is drawn by one educator due to time constraints. It would be better if there was a educator participation in such activities as it would ensures that educators are responsible and are accountable for the decisions they take.

Interviewee 10: Our classes are overcrowded and as a result it is difficult to see to it that all these learners are learning effectively. If we had less numbers of learners we would be motivated to integrate technology.

4.7.1.9 Theme 9: School Management Teams need to concertedly manage the integration of computer technology into the teaching and learning situation and thereby empower educators through workshops, skilling, and reducing learner: educator ratio in computer technology classes.

Interviewer: Do you have personnel in place who are responsible for the implementation of the standards and technology integration into the teaching and learning practice?

Interviewee 1: We only have two educators who are computer managers. These educators are responsible for cleanliness and safety of the laboratory.

Interviewee 2: We do not have such people in our school. No one is responsible for standards in technology implementation. We as educators determine the standards ourselves.

Interviewee 3: No one is responsible. No one checks what we are doing in the lab. We all do what we feel like doing.

Interviewee 4: The ultimate responsibility for the computers lies with the principal but I think they are just responsible for ensuring their safety. I have never seen him going to the computer laboratory or checking what educators are doing.

Interviewee 5: We have SMTs that are responsible for teaching standards but they do not check how we integrate technology. No one does.

Interviewee 6: I do not think there is anyone within our school who knows what to do concerning checking standards in technology integration. I understand that there should be set standards for everything we do within the school but for computer integration there are no set standards and no responsible personnel.

Interviewee 7: We do not have such personnel.

Interviewee 8: No one. What standards would they be responsible for? We do not have any guide for this because the only policy we have is for GOL which is about the management of the computer lab.

Interviewee 9: No one is responsible.

Interviewee 10: No one.

4.7.1.10 Theme 10: School Management Teams have not developed standardized strategies for integrating technology into the learning and teaching situation, and there seems to be inadequate will from school management teams to empower educators on computer technology competencies.

Interviewer: Who in your school is responsible for tracking the progress of staff as they move towards integrating technology?

Interviewee 1: No one tracks the progress.

Interviewee 2: The two computer managers that we have within the school are not responsible for tracking progress but for opening and locking the lab. They are mere caretakers.

Interviewee 3: No one tracks progress.

Interviewee 4: I am not sure if SMT members should not be doing this as they are responsible for tracking the progress of the work we do but I do not think they have any clue.

Interviewee 5: No one tracks progress.

Interviewee 6: We check our own progress but there is nowhere we account for failure.

Interviewee 7: No one tracks progress.

Interviewee 8: No one.

Interviewee 9: It is too early to talk about tracking progress we only had access to computers at the beginning of 2006. We are still learning the basics may be after two to three years there can be people who are responsible for tracking progress not now.

Interviewee 10: No one.

4.7.1.11 Theme 11: The development of both educators and learners on computer technology is not monitored which could be an indication that school management teams are not passionate with the effective integration of computer technology into the teaching and learning situation.

Interviewer: How does your school verify that educators are using the equipment and resources available?

Interviewee 1: I think you are talking about some kind of a register. We do not have anyone. Educators who want to use the resources are free to do so and those who do not want to are also free to do so.

Interviewee 2: We do not have a way of verifying this.

Interviewee 3: They are used by people who want to.

Interviewee 4: I think in an informal way like educators know who uses the computer lab most.

Interviewee 5: We do not have a formal way of doing it we just know it.

Interviewee 6: We do not have a way of verifying.

Interviewee 7: In an informal way other educators just know.

Interviewee 8: We do not have a way of verifying.

Interviewee 9: We do not have a way of verifying.

Interviewee 10: We do not have a way of verifying.

4.7.1.12 Theme 12: School Management Teams lack controlling ways of determining the effective use of available computer equipment and resources by educators

4.8 CONCLUSION

This chapter analysed and interpreted the results of the empirical research. Findings that were identified form part of the summaries and recommendations in the next chapter.

CHAPTER FIVE

SUMMARIES, RECOMMENDATIONS AND CONCLUSION

5.1 INTRODUCTION

In this chapter summaries of both the literature review and the empirical research findings are presented, with a view to making recommendations for the practical implementation of these findings and for further research.

5.2 SUMMARIES OF BOTH LITERATURE REVIEW AND EMPIRICAL RESEARCH

This section provides both the findings from the literature review and empirical research.

5.2.1 Findings from the literature study

Computer technology offers learners more highly motivating and comprehensive individualized learning experiences than the traditional group classroom exercises of the past which solely relied on text and exercise books (see paragraph 1.1). The literature review study also highlighted that primary school learners who received brief daily computer-aided teaching lessons as a supplement to teaching showed gains equivalent to between one to eight months of teaching over their peers, who received traditional teaching only (see paragraph 1.1). Increases in learner attendance, motivation and attention span have also been reported by various researchers (see paragraph 1.1). Computer technology can also be very accommodating, for example, computers can reach learners at different study ability levels, any time of the day or night. Additionally, the sense of independence, self-regulation and accomplishment a computer offers helps learners fuel their self-confidence and self-regulated learning. Relying on a computer as a tool may be one of the most effective ways to build both a learner's learning skills and self-esteem (see paragraph 1.1).

The literature review again highlighted that as learners enter the workforce in the coming decades, they will undoubtedly:

- discover that to continue to be effective in their jobs, they will need to keep pace with the onslaught of new information;
- need to continue to learn and to take advantage of new information technologies that allow them to learn and work more efficiently, effectively and productively (see paragraph 1.1).

It is for this reason that various researchers on computer technology have asserted that schools should make every effort now, more than ever before, to introduce learners to computer technology because computers should be a learning, creativity and productivity tool for everyone in the twenty-first century (see paragraph 1.1).

5.2.2 Findings from the empirical research

The empirical research was conducted in two phases the quantitative phase and the qualitative phase as mentioned in sub-section 1.3.2.1. Findings from the quantitative research are written first and thereafter the findings from the qualitative research follow.

5.2.2.1 Findings from the quantitative research

The following findings of the empirical investigation correlate with the research aim 2. The findings revealed that:

- most schools do not articulate a vision of learning that incorporates key precepts of education transformation (see paragraph 4.3 B₁); very few of these schools' vision of learning incorporates technology as a key component that can promote a challenging curriculum and instructional practices that engage learners (see paragraph 4.3 B₂); schools do not fully emphasise technology-related research projects as a solution to real-world problems (see paragraph 4.3 B₃); most principals educators and other key staff members partially understand their unique roles in this vision of learning and agree that technology needs to continue to be developed as

as key tool to change instruction and learning (see paragraph 4.3 B₄); only a small percentage of the participants indicated that their school's vision of learning fully consider the needs of learners disadvantaged by their socio-economic status or other variables that may place them at risk of school failure (see paragraph 4.3 B₅); and schools' vision of learning of most participants does not promote equity as these schools consider new uses of technology (see paragraph 4.3 B₆).

The following findings of the empirical investigation correlate with the research aim 3. The findings reveal that:

- a very small percentage of the respondents indicated that their schools fully developed a professional development plan that addresses the skills educators will need to integrate technology into the curriculum (see paragraph 4.4 C₁); a very small percentage of the respondents indicated that their schools fully budgeted sufficient monies for professional development and support for educators and instructional staff that will increase both their knowledge base about technology and their understanding of authentic learning (see paragraph 4.4 C₂); the majority of the respondents' schools to some extent projected monies for professional development and technological support for school staff over a sufficient time period (see paragraph 4.4 C₃); the majority of the respondents indicated that their schools' governing body members partially understand and support a professional development plan and its budget (see paragraph 4.4 C₄); a very small percentage of the respondents indicated that educators, principals and other staff have been able to fully make an input into determining the type, content, and length of professional development necessary to integrate technology through out their instruction (see paragraph 4.4 C₅); and very few respondents indicated that their schools professional development plan fully addressed how technology can accelerate and enhance learning for learners with special needs (see paragraph 4.4 C₆).

The following findings of the empirical investigation correlate with the research aim 4. The findings revealed that:

- school's plans for technology for the most part ensured that computers will be placed in a combination of classroom and computer labs to ensure equitable access for all learners in all areas (see paragraph 4.5 D₁); schools have to some extent changed methods of instruction to ensure that learners who typically experience less challenging content and remediation can use technology to engage with challenging ideas and the solution of real-world, relevant problems (see paragraph 4.5 D₂); school's governing body and community members have never discussed and planned, with the school or district, for school-initiated ways in which computers can be used at home on a contractual basis (see paragraph 4.5 D₃); schools never involved family and community members in discussions of computer technology and ways in which they can help their children at home and also learn important skills (see paragraph 4.5 D₄); and school's instruction is not monitored at all to ensure that one group or gender does not dominate access (see paragraph 4.5 D₅).

The following findings of the empirical investigation correlate with the research aim 5. The findings revealed that:

- schools had for the most part researched not only the amount of resources necessary to implement technology into the vision of learning and learning but had also made plans to ensure that the school can acquire those resources (see paragraph 4.6 E₁); school's plan for technology for the most part ensures that all learners within the school use computers (see paragraph 4.6 E₂); school's budget for technology only partly include adequate personnel to support educators as they acquire necessary knowledge to integrate technology through their instruction (see paragraph 4.6 E₃); and school's budget plans to some extent included incentives for educators who seek out and acquire additional resources in the form of grants or other monies to support the infusion of technology in their instruction (see paragraph 4.6 E₄).

5.2.2.2 Findings from the qualitative research

The empirical investigation revealed that:

- the integration of technology in the classroom means facilitation of effective learning and teaching, and offers learners opportunities to explore various careers (see 4.7.1.1);
- the integration of technology into the curriculum demands planning abilities, organizational skills and empowerment of educators, including the empowerment of learners (see 4.7.1.2);
- schools do not have a mandatory obligation to enforce the teaching of computer technology to their learners (see 4.7.1.3);
- educators lack computer technology skills and there is an element of mandatory educational management policies on the integration of computer technology into the teaching and learning situation (see 4.7.1.4);
- computer technology in all computer programmes is necessary if educators are to be successful and competent in effective teaching of learners (see 4.7.1.5);
- there is a great need for an intensive training of educators on computer technology and the various softwares which are available for educators in various learning areas (see 4.7.1.6);
- integrating computer technology into the curriculum during this social constructivist period in South Africa necessitates facilitation skills which develop learners' critical thinking skills, including drawing, typing and research skills (see 4.7.1.7);
- computer technology also has capacity to enhance educators' efficient and effective school, class and learning area administration, including their personal professional development (see 4.7.1.8);
- School Management Teams need to concertedly manage the integration of computer technology into the teaching and learning situation and thereby empower educators through workshops, skilling,

and reducing learner: educator ratio in computer technology classes (see 4.7.1.9);

- School Management Teams have not developed standardized strategies for integrating technology into the learning and teaching situation, and there seems to be inadequate will from school management teams to empower educators on computer technology competencies (see 4.7.1.10);
- the development of both educators and learners on computer technology is not monitored which could be an indication that school management teams are not passionate with the effective integration of computer technology into the teaching and learning situation (see 4.7.1.11); and
- School Management Teams lack controlling ways of determining the effective use of available computer equipment and resources by educators (see 4.7.1.12).

5.3 RECOMMENDATIONS

This section provides both the recommendations for further research and practical implementation of computer technology integration into the school curricular activities.

5.3.1 Recommendations for further research

The current research provides an understanding of the issues that affected the educators in their use of computer technology in the teaching and learning situation. The scope of this study is limited to school situations in the Vaal Triangle area of the Gauteng Province. More research is needed for the whole of the Gauteng Province where the population sample will consist of all the Districts of Education in the province. Such comprehensive research will help both the Gauteng Governments and its Department of Education to understand computer literacy levels of its learners and educators and also highlight underlying factors that help/hinder technology implementation in all

its schools. There is also a need to conduct such research in the whole country in order to assess and evaluate the extent to which South African schools have developed in the integration of information and communication technology in both intra- and extra-curricular activities. This country cannot afford to lag behind America and Europe in integrating computer technology in the curriculum of its schools if it hopes to be a First World country.

While the training of educators in the implementation of the integration of the computer technology in school curricula is important, schools should also help students, the ultimate targeted beneficiaries of the efforts of introducing computer technology in the learning and teaching situation. This study looked at the Vaal Triangle's educators, principals and computer managers' perceptions of the extent of professional development and technological support they receive from their schools. A future research study might also include learner population sample to investigate the influence of computer technology in self-regulated learning. Such a study could look at the way in which the integration of computer technology into learning and teaching situations changes the way learners learn. A similar, future research study might investigate whether the teaching style of the educators changes to being more learner-centred as a result of such development and technological support, or whether the implementation only makes the educators use technology as an add-on in their classrooms.

Another focus of future research could be the use of the suggested Technology Integration Model (TIM) to see its effectiveness in technology integration. This model integrates the findings of research as well as ideas of the key factors that could influence technology use in the classroom. Upon further study this model has the potential to be applied to a variety of school settings for technology integration. Qualitative or quantitative research could be conducted to verify that the suggested model will work in other school settings.

5.3.2 Recommendations for practical implementation of findings

The data analysis of the results of this research led to the following recommendations, which have implications for integration of computers in the classrooms:

5.3.2.1 Recommendation 1: Schools should employ educators who have been academically and professionally educated and trained in computer technology (see research aim 5)

Professional development is the critical item highlighted by the respondents in the empirical research of this study. There is therefore an immediate need for educators to be both academically and professionally educated and trained on technology. The Department of Education should skill all educators in computer skills, especially veteran educators who did not in the past have the opportunity to have computer technology integrated in their colleges of education or university education and training. They definitely need to have comprehensive education and training on computers. This professional development of educators should be organized, based on educators' different levels of computer skills. The focus of the training should be on integrating computer technology in the classroom and curriculum implementation practices.

The only way in which the Department of Education in South Africa can promote both computer literacy and competency for both learners and educators at schools is by employing educators who have been educated, trained and specialized in integrating technology into teaching and learning. This means that the Department of Education should as a matter of urgency develop partnerships with all the Universities' Faculties of Educational Sciences so that universities can train educators at pre-service level on skills to effectively integrate ICT in teaching and learning that are needed to produce competent computer technology educators. The Department of Education can also conduct in-service courses for educators, on a massive scale, to be capacitated in computer technology.

On the basis of the foregoing paragraphs, it is extremely important that educators are continually evaluated on the way and manner in which they integrate computers in their classroom practices. In order to achieve this, the education districts should have the knowledge and skills to evaluate educators while using computer technology in their classroom teaching and learning activities. It stands to reason therefore that even education district officials need to be skilled by in-service education and training in computer technology integration in classroom teaching and learning activities.

5.3.2.2 Recommendation 2: School governing bodies and school management teams should strategically budget for computers for every learner in their school (see paragraph 1.1 and research aim 4)

If South African schools have to prepare all learners for the technological world of this twenty-first century, it is imperative that school governing bodies and school management teams should, through their Section 21 as provided for by the Department of Education for all self-managing schools, concerted and proactively budget for computers for every learner or alternatively make enough financial provision for computer laboratories which should be sufficiently stocked with computers for learners to conveniently work with when they are researching for their projects. In fact, computer laboratories at schools are nowadays as important and necessary for school academic learning and teaching as libraries.

The above paragraph means that all schools, according to the recommendations of the researcher, should have well-equipped computer laboratories where each learner can be able to be seated in front of a computer. In other words, all schools' computers should have the educational software needed to perform lesson activities, a projector, a television monitor, networking, printers, internet connection, internet-filtering software, and the same versions of software in order to perform the required activities on all computers. Moreover, there is a need for more computers in the classrooms, probably four or five for learners and educators to use during teaching and learning activities. The classroom computers as well as the classrooms should also be equipped with the software already mentioned. Having five or more

computers per classroom, an educator would be able to team up learners, and by using rotation one can achieve, besides the goals of the lesson, collaborative learning, and higher order strategic learning skills, as well as computer technology skills.

Educational software and the computer applications can be effective tools in promoting effective teaching and learning at schools and to integrate computer technology in classroom teaching and learning activities and the school curriculum. It is therefore important that school governing bodies and school management teams should develop or buy educational software and computer applications appropriate for all grades and learning areas at their schools. The materials need to be aligned with the curriculum and integrated in the curriculum as choices, or as alternatives to the educators. It is also imperative that schools should work in partnership with computer software service providers who specialize in computer technology in teaching and learning or educationally related issues, in order to select/choose, develop or translate educational software/computer applications for all grades and learning areas. This is also the reason that necessitates that schools employ educators with the knowledge and skills of computer technology.

On the basis of the researcher's recommendation in this section, schools need enough money to buy computer hardware and software which without any doubt necessitates strategic budgeting.

5.3.2.3 Recommendation 3: School Governing Bodies and School Management Teams should be skilled on computer technology strategic management (see research aim 3)

The in-service education and training of school management teams and school governing bodies on computer technology management will enable them to budget efficiently and effectively for both computer hardware and software so that computers and their software are controlled effectively for daily use at schools. Strategic management will also help them to plan accordingly. They can work together with computer managers.

5.3.2.4 Recommendation 4: Schools should work with families and communities (see research aim 2)

Working together with parents and the business community can facilitate financial and material donations for computer purchase and acquisition. Business people can always donate computers or funds for their purchase because they know that computer literate graduates from schools are assets for both business and community.

5.4 CONCLUSION

This research investigated, by means of both a literature review and empirical research, the extent to which integration of computer technology has been implemented in a population sample of principals, computer managers, and educators in the Vaal Triangle. Empirical findings were made and recommendations were suggested by the research for both future research and practical implementation.

The researcher hopes that the contributions made in the form of suggestions will help South African school governing bodies and school management teams see the need for the integration of computer technology in the teaching and learning settings of the twenty-first century.

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QUESTIONNAIRE FOR EDUCATORS, COMPUTER MANAGERS AND PRINCIPALS

SECTION A: DEMOGRAPHIC INFORMATION

1. Indicate the type of the school you are working at

Primary		Secondary		Tertiary	
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2. Where is the school located?

Town		Township		Farm	
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3. The enrolment of your school is

Less than 500		Between 500 and 800		800 plus	
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4. Indicate your teaching designation

Educator		Computer Manager		Principal	
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5. What level of education have you achieved?

Pre-Matric		Matric+Diploma		Matric+Degree	
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6. Number of computers in your school

-10		20-30		40-50	
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7. Indicate the grades that use computers at your school

Grade 1-3		Grade 4-7		All grades	
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8. Indicate the number of computer managers at your school

1		2		3	
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SECTION B: TECHNOLOGY AND EDUCATORS OF LEARNING

	Fully	For the most part	Some what	Not at all
1.To what extent has the school clearly articulated a vision of learning that incorporates key precepts of education transformation?				
2. To what extent does the vision of learning incorporate technology as key component that can promote a challenging curriculum and instructional practices that engage learners (e.g. collaborative learning, problem-based learning, and projects-based learning?				
3. To what extent does the vision of learning emphasise projects and the solution of real world problem?				
4. To what extent do educators, principals, and other key staff understand their unique roles in this vision of learning and agree that that technology needs to continue to be developed as key tool to change instruction and learning/				
5. To what extent does your school vision of learning consider to the needs "disadvantaged" because of their socio-				

economic status or other variables that may place them at risk of school failure?				
6. To what extent does your school's vision of learning promote equity as you consider new uses of technology (e.g. programs to take laptops home, with parents to use school equipment in return for classes)?				

SECTION C: TECHNOLOGY AND PROFESSIONAL DEVELOPMENT

	Fully	For most part	Somewhat	Not at all
1. To what extent has the school developed a professional development plan that address the skills educators will need to integrate technology into the curriculum?				
2. To what extent has the school budgeted sufficient monies for professional development and support for educators and instructional staff that will increase both their knowledge base about technology and their understanding authentic learning?				

3. To what extent has the school projected monies for professional development and technological support for school staff over sufficient time period (e.g. five years)?				
4. To what extent does school governing body members and community members understand and support your professional development plan and its budget?				
5. To what extent has educators, principals, and other staff have input into determining the type, content, and length of professional development necessary to integrate technology through out their instruction?				
6. To what extent does the professional development plan address how technology can accelerate and enhance learning for special needs learners (e.g. economically disadvantaged)?				

SECTION D: TECHONOLGY AND EQUITY

	Fully	For the	Some what	Not at all
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		most		
1. To what extent do the school plans for technology ensure that computers will be placed in combination of classroom and computer labs to ensure equitable access for all learners in all areas?				
2. To what extent have the school changed typical methods of instruction to ensure that learners who typically experience less challenging content and remediation can use technology to engage with challenging ideas and the solution of real-world, relevant problems?				
3. To what extent has the school governing body and community members discussed and planned for school-initiated ways in which computers can be used at home on a contractual basis with the school or district?				
4. To what extent has the school involved family and community members in discussions of computer technology and ways in which they can help their children at home and also learn important skill?				
5. To what extent is the instruction monitored to ensure that one group or gender does not dominate access?				

SECTION E: TECHNICAL AND RESOURCES.

	Full y	For the most part	Some what	Not at all
1. To what extent has the school researched not only the amount of resourced necessary to implement technology into the vision of learning but also made plans to ensure that the school can acquire those resources?				
2. To what extent does your plan for technology ensure that all learners within the school use computers?				
3. To what extent does the budget for technology include adequate personnel to support educators as they acquire necessary knowledge to integrate technology through their instruction?				
4. To what extent does the school budget plan include incentives for educators who seek out and acquire additional resources in the form of grants or the other monies to support the infusion of technology in their instruction?				

ADDENDUM 2

INTERVIEW SCHEDULE

What does the phrase 'integration of technology into the classroom' mean to you?

How are you assisting your school with the integration of technology into the classroom?

How is the integration of technology into the classroom being implemented in your school?

Ideally, how should integration of technology into the classroom be implemented?

As a teaching practitioner what professional development activities do you think might facilitate the integration of technology into the classroom?

In your opinion which factors do you think prevent/inhibit the implementation of integration of technology into the classroom?

As a teaching practitioner what do you believe is the role of instructional technology in education?

How do you use technology for your personal and or professional work?

In your opinion which factors enhance the implementation of integration of technology into the classroom?

Do you have personnel in place who are responsible for the implementation of the standards and technology integration into instruction?

Who in your school is responsible for tracking the progress of staff as they move towards integrating technology?

How does your school verify that educators are using the equipment and resources available?