A constructivist learning event using computers at the Instituto Superior de Ciências de Educação (ISCED) - Angola

by

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Summary

The aim of this study was to investigate how well pre-service teachers are being prepared by the Computers in Education course to integrate computers into their teaching methods by the Faculty of Education at the *Instituto Superior de Ciências de Educação* (ISCED) in Lubango, Angola. The study used a constructivist learning event devised by the researcher to assess how well the selected sample of pre-service teachers were able to use computers and the Internet to fulfil a series of tasks contained in the constructivist learning event under carefully controlled research conditions. After they had completed these tasks under experimental conditions, the researcher and her two assistants used various means to assess the performance of the participating groups in these activities.

A qualitative case study approach was used for this study. The case study took place at ISCED in Lubango because ISCED is the only institution of higher education in Angola that uses computers to prepare pre-service teachers to integrate computer technology with their teaching. The course in which this takes place is known as the Computers for Education course. Twenty-one pre-service teachers and the two Information and Communication Technology (ICT) teachers of the Computers for Education from ISCED participated voluntarily in the study. The data collection instruments used included questionnaires for the pre-service teachers and ICT teachers; observation checklists for the pre-service teachers; interviews of pre-service teachers and ICT teachers, and scoring rubrics for the pre-service teachers' task assessment documents. The data analysis method used in this study was that of interpretive analysis.

The theoretical framework used to scaffold this study was the theory of constructivism devised by Bruner (1966). Bruner states that constructivism is the "theory of learning, where learning is seen as an active process in which students construct new ideas or concepts based upon their current or past knowledge". In constructivist learning events of this kind, students select and transform information, construct hypotheses and make their own decisions in reliance upon their own cognition and previous knowledge and experience. Cronjé's Model of Four Quadrants (2000), which enables a researcher to plot

objectivism as complementary to constructivism, was used by the researcher as the basis for an analysis of data. The Model of Four Quadrants describes how learning theories such as behaviourism and constructivism exist as opposites in the quadrant upon which the model is based. An objectivist or behaviourist approach to teaching and learning assumes that knowledge exists essentially and independently outside the minds of both learners and teachers, and behaviourist methods of teaching effect a transfer of objective knowledge from the mind of the teacher to the mind of the student. In contrast to this, the constructivist approach is based on the assumption that all meanings are subjectively constructed in the human mind, and that learners acquire knowledge (and therefore education) by creating their own meanings while engaging in the solution of authentic learning tasks devised by the teacher. Constructivism does not recognise the existence of any kind of objectively independent shared reality that can be transferred materially from one mind to another. Although these two approaches are radically different from one another, and although they exist conceptually as polar opposites in Cronjé's Model, elements from both models can be utilised to achieve a desired learning outcome. What the researcher has suggested in her analysis, conclusions and recommendations is that elements from both learning theories described in the model can be successfully used to teach ISCED students how to integrate computer technology into their teaching.

Current teaching and learning practices at ISCED are predominantly behaviourist in method and outcomes since the ICT teachers at ISCED use mainly the lecture method for teaching. For formative assessment, the present teachers use question and answer methods. For summative assessment, they use multiple-choice questions, schedules that require students to insert information into blank spaces, projects, and essay-type questions. In contrast to this, they use learner-centred constructivist forms of teaching such as projects, group work and verbal expression of appreciation to encourage learner performance. The teaching of the Computers in Education course at ISCED may therefore be said to combine both behaviourist and constructivist methods of teaching.

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Key Words

Behaviourist theory
Constructivist theory
Cooperative learning
Individual learning
Learner-centered
Organizational dimensions
Pedagogical dimensions
Pre-service teacher
Teacher-centered
Technical dimensions

List of Abbreviations

Abbreviation	Meaning
ISCED	Instituto Superior de Ciencias de Educacao
RDC	Republica Democratica do Congo
MPLA	Movimento Popular de Libertaçao de Angola
UNITA	Uniao Nacional para Independência Total
UAN	Uniersidade Agostinho Neto
ICT	Information and Communication Technology
HE	Higher Education
FNLA	Frente National de Libertaçao de Angola
WHO	World Heath Organisations
OMS	Organizacao Mundial de Saude
IMM-PBL	Interactive Multimedia Problem-Based Learning
OTA	Office Technology Assessment
ISTE	International Society for Technology in Education
NCES	National Centre for Education Statistics
NCATE	National Accreditation of Teacher for Education
SEDL	Southwest Educational Development Laboratory

CHAPTER 1

Introduction

1.1 Introduction

This essay reports on an objectivist-constructivist investigation into integrating computers into the learning process for pre-service teachers at the *Instituto Superior de Ciências de Educação* (ISCED). The practical research component of this study involved a select sample of pre-service teachers at the Institute. Each pre-service teacher was given the same constructivist learning activity. This constructivist learning activity was designed to give the pre-service teachers in the sample an opportunity to discover and demonstrate in practice the range of their computer skills, knowledge and expertise. In theory this would provide the researcher with information about how efficiently these pre-service teachers would be able to use computers in their future teaching practice, and the extent to which they would be qualified to integrate their teaching with computer-assisted learning when they themselves became teachers.

The assumption on which this research is based is that teacher education programmes need to train student teachers so that they will be in a position to integrate technology into their teaching of the curriculum. Pre-service teachers who are in such programmes must be given opportunities to apply new technologies such as computers in classroom settings. They also need to see how technology-assisted teaching and learning can be more efficient and effective than traditional methods (Brennan, 2000, p. 2; Sahin, 2003). The goal of such teacher education programmes is to help future teachers to realise just how meaningful, authentic and necessary technology can be for their teaching (Duran, 2000, p. 5).

Duran (2000) deals with the topic of how technology can be integrated into an elementary teacher education programme. One of his most important findings was that the pre-service teachers whom he investigated had not been adequately trained in the integration of technology in a classroom. More specifically, they had not been given sufficient *time* to practise the kind of hands-on skills that a teacher needs to become a skilled practitioner in the art of integrating technology with teaching in a classroom. Duran therefore recommended that teaching institutions integrate technology into their own programmes across the board so that student teachers would have opportunities to acquire technological proficiency merely by engaging in their day-to-day learning activities. If Duran's advice were to be followed, information technology would be integrated into methods and curriculum courses rather than be a feature of courses specifically designed to teach technological skills.

Constructivism has been the subject of many research studies over the last decade. According to Tam (2000, p. 56), "the central tenet of constructivism is that learning is an active process and that learning is determined by the complex interlay among learners' existing knowledge and the social context, and the problem to be solved."

Constructivism is therefore able to generate ideas and principles about learning that have important implications for the construction of technology-supported learning environments. One of these implications, which is also the central proposition in this study, is that there is a need to "embed learning into authentic and meaningful contexts" (Tam, 2000, p. 56; and Sahin, 2003, p. 73).

Constructivism has exerted a powerful influence on teachers and curriculum developers because it has changed the way in which they see learners. Instead of defining learners as individuals who are passive and ignorant, learners are regarded as active participants in the learning process because they use multiple learning styles and methods to achieve their goals. Brooks and Brooks (1993) suggest that the following conditions need to be fulfilled if learners are to become active participants in their own learning:

- Learners need to be trained to engage in group activities, interpretive discussions and brainstorming in which they themselves take the initiative.
- Teachers need to be convinced of the necessity and importance of learner autonomy and learner initiative in the learning process.
- Learner tasks need to be structured around open-ended questions. Learners need to be given enough time to formulate their responses to such questions. Learners will only develop higher thinking skills if they are encouraged to learn in this way.
- Learners need to be taught to participate freely and without self-consciousness in dialogues with their teachers and with one another. They need to be trained to formulate their own hypotheses and to challenge the hypotheses of others in the context of the free discussion and inquiry.
- Learners need to be taught how to use raw data, primary sources and interactive materials correctly (Brooks & Brooks, 1993, p.p. 101-118).

The kind of assessment process that is used in a constructivist classroom is unique to constructivist education. From a constructivist point of view, assessment has to be based on the *process* of learning. "The focus is on the quality of the learners' understanding, its depth and its flexible application to related contexts" (Lindschitl, 1999, p. 192).
Even though constructivist instructional design is extremely effective, it has been criticised for the following reasons:

- It is expensive to develop
- It requires technology for its implementation.
- It is very difficult to evaluate (Tam, 2000, p. 32).

1.2 Background information about Angola and the *Instituto Superior de Ciências de Educação* (ISCED)

1.2.1 Description of Angola

Angola lies adjacent to the Atlantic Ocean on the south-western coast of southern Africa. It is situated to the south of the Democratic Republic of Congo (DRC), to the north of Namibia, and to the west of Zambia, and covers an area of approximately 1,246,700 square kilometres. Angola is divided into 18 provinces. Luanda, the capital, is situated in

Huila, the largest of the Angolan provinces. The official language of Angola is Portuguese, and the Angolan population is estimated to number fourteen million.

Like most African countries, Angola only achieved independence after a prolonged liberation struggle. In 1975, the year in which the country was granted independence by Portugal, violent clashes broke out between the MPLA and the UNITA/FNLA coalition. The full-scale war occasioned by the enmity between these two movements lasted for 27 years, and only came to an end in April 2002. Angola possesses an enormous wealth of natural resources such as oil, diamonds and gold. Part of Angola are also ideal for the cultivation of crops such as coffee. Figure 1.1 (below) illustrates the scale of Angola, its main towns, and the countries that surround it.

Telecommunication systems were severely hampered by the prolonged war. Telephone access is currently limited to just over 69, 700 telephone lines, and two Intelsat satellites provide satellite coverage. At the time of writing there are over 30,000 users of the Internet. After the civil war had ended, the government made the development of the telecommunication sector one of the main priorities for the country.

Figure 1.1: Map of Angola (Encarta 1995-1998)

1.2.2 Description of the main components of the Angolan educational system

The Angolan educational system is divided into the following three sectors:

- *Ensino de Base.* Primary education in Angola takes a child through three distinct levels. The first level lasts for four years, the second level lasts for two years, and the third level lasts for two years. Primary education therefore lasts for a total of eight years altogether.
- *Ensino Medio.* The intermediate phase of Angola education lasts for four years, while the *Ensino pre-Universitario* lasts for three years (depending on the speciality involved).
- *Ensino Superior.* University education in Angola usually lasts from four to six years. The *Agostinho Neto University*, a state-sponsored university, consists of a number of the faculties. In addition to this state-sponsored university, Angola possesses other private universities such as the *Universidade Catholica de Angola.* The Angolan educational system is summarised in Appendix 1.1.

Most learners in Angola begin their schooling at the age of five or six years. Some enter primary school by enrolment in kindergarten classes. Others progress into primary education without having experienced kindergarten schooling. Participation in the first level of primary school education is compulsory for all Angolan children.

Children with special needs are catered for in the education system by specialised forms of education that include special schools for disabled children and literacy schools for adults at the level of the *Ensino de Base.* After *Ensino Medio* (the intermediate phase), learners who aspire to become teachers complete four years of *Ensino Medio Normal (EMN)* education before being admitted to the *Instituto Superior de Ciências de Educação* (ISCED) teacher training college. At ISCED, students are trained to become either primary school or secondary school teachers. The *Ensino Medio Telecommunication* (EMT) provides yet another kind of specialised education (Gazette of the Republic of Angola, 2001).

After they have completed their intermediate phase of education, all learners may apply to be admitted to any university faculty to pursue studies whether professional or other. Thus, for example, learners from EMN may apply to ISCED if they intend to specialise in order to become teachers.

1.2.3 *Instituto Superior de Ciências de Educação* (ISCED)

ISCED was founded in Lubango, Angola, in terms of the Angolan Government Report of 2002/2003 on 30 August 1980. ISCED trains students to become school and college teachers. Currently about 1,100 students are enrolled for various courses and specialisations at the college. The college is run by 88 members of staff. This number includes both teachers and administrative staff (Angolan Government Report, 2002/2003).

ISCED has two computer laboratories, each of which is equipped with 30 computers. The computers in the laboratories are Pentium 3 computers with 800MHz and 128MB of RAM, and all of them are connected to the Internet. ISCED provides opportunities for research and investigation, and for cultural, scientific, technical and human resource information and research. It also seeks to develop cultural exchanges with the public at large as well as private institutions both national and foreign.

ISCED currently offers tuition in twelve subjects that include Mathematics, Physical Science, Biology, Modern Languages (French, English and Portuguese), and Computers for Education. ISCED has a modern museum that houses diverse collections of flora and fauna fossils. ISCED is situated in the city of Lubango, in Huila province. The main building of ISCED is depicted in Figure 1.2 below.

Figure 1.2: The main building of ISCED in Lubango

1.3 Purpose of the study

The purpose of this study is to investigate how the researcher's constructivist learning activity can be used to assess the computer skills of a select group of pre-service teachers at ISCED. It will also seek to establish how much students know about integrating computers into the teaching and learning process in a classroom.

1.4 Statement of the problem

Education has undergone a significant shift in the way "educators and psychologists think about the nature of human learning and the conditions that best promote the varied dimensions of human learning" (Applefield, Huber, & Moallem, 2001, p. 38). Cooper (1993) suggests that instruction has undergone a paradigm shift from behaviourism to cognitivism and now to constructivism. Constructivism exerts such a powerful influence in contemporary education that many professional groups are currently making concerted efforts to reform the methods and dynamics of classroom instruction so that they will harmonise with constructivist premises. Pechman (1992), for example, informs us that professional groups such as The Association for Supervision and Curriculum Development, the National Council for Teachers of Mathematics, and the American Association for the Advancement of Science all advocate a shift away from direct instruction toward "active, inventive instruction" – in other words, constructivism (Pechman, 1992, p. 34).

Constructivism was one of the most influential learning theories of the last two decades of the twentieth century, and it continues even now to exert more and more influence over educationists in this new millennium. Educationists have tended to move away from behaviourism because behaviourists believe that "knowledge of the world exists independently of the learner and then it becomes internalized as it is transferred from the external reality [the teacher] to an internal reality [the learner]" (Driscoll, 1994). A constructivist theory of learning, by contrast, proposes that "learners' conception of knowledge is to be derived from a meaning-making search in which learners engage in the process of constructing individual interpretations of their experiences" (Applefield et al., 2001, p. 37). This paradigm shift in educational theory is changing the way in which teachers conceptualise the teaching-learning process as they incorporate constructivist premises as the basis for their day-to-day teaching. What should prospective teachers know about this theory and its educational implications?

I designed this study so that it would give me an opportunity to investigate and analyse the ways in which pre-service teachers would use ICT in a constructivist learning event at ISCED. The Introduction to Technology course at ISCED focuses on helping pre-service teachers to develop skills for using technology and integrating it into their practice. Technology courses such as this need to compensate for the deficiencies in the teacher education programme by creating the conditions in which a learning theory such as constructivism can be used in practical teaching (Niederhauser, Salem & Fields, 1999).

Duffy and Jonassen, (1992) observe that most pre-service teachers have "a vision of schooling that is grounded in didactic instructional methods. Didactic pedagogy reflects on behaviourism tradition that centres on the efficient transfer of knowledge to students and the replication of basic skills." It should be noted, however, that technology is basically theory-neutral, and that it is therefore able, as an instructional tool, to support various different pedagogical orientations. In spite of this, it does not follow that the *way* in which technology is used in the classroom is theory-neutral because the teacher sets up the technology to conform to a particular pedagogical orientation of teaching and learning. (I shall expand on this observation in greater detail in chapter 2.) I could

therefore design and structure activities in the Computers for Education course at ISCED to help pre-service teachers to compare and contrast the two learning theories (behaviourism and constructivism) on the basis of their own learning experiences during the study. This is in fact what I did.

1.5 Critical research questions

The central (critical) research question of this study is: What are the differences between the objectivist/behaviourist approach and the constructivist approach in the ICT training of the pre-service teacher?

The study was also structured in terms of the following sub-questions:

- What are the pre-service teachers' views about the ways in which computers could affect their teaching role in the classroom?
- What are the implications of an instructional approach for pre-service teachers that focuses on constructivist pedagogy that is supported by the use of computers?
- What challenges are inherent in the use of computers in a constructivist instructional approach?

1.6 Design of the study

The present study is a qualitative research case study because the research study was conducted only at ISCED. It is also a case study because I wanted to understand what the pre-service teachers themselves thought about the way in which they were being prepared to use computers in their future careers. ISCED is the only teacher training college in Huila Province, and they use computers for teaching the Computers for Education course.

I selected ISCED for this study, firstly, because it was the only institution of its kind in Angola that had computer laboratories and that offered a Computers for Education course. As I have already noted, I had decided to use computers in a constructivist learning event for pre-service teachers at ISCED. Secondly, there were already pre-service teachers following the Computers for Education course whom I had selected to participate in the research study. While a total of thirty students were enrolled for this course, only twenty-one pre-service teachers volunteered to participate in the study.

Several research instruments were used in the study. I used questionnaires to obtain (1) the students' understanding of how computers should be used in a classroom situation, and (2) the students' understanding of the way in which the pedagogical process was being used to prepare them to integrate their teaching with computers in the classroom. I therefore conducted a series of face-to-face interviews with the ICT teachers and their pre-service teachers. The purpose of the interviews was to solicit the views of pre-service teachers about (1) the constructivist learning that they had completed, and (2) the way in which constructivist instruction was being applied in schools. I also wanted to know what their views were about the effect of the constructivist learning event and how they proposed to integrate computers with their own teaching once they had graduated.

I used an observation checklist to observe and track the progress of the pre-service teachers as they worked on the constructivist learning event. Both the researcher and the

ICT teachers participated in the observation process as participant observers. The participant observers also used the observation checklist to assess the pre-service students while they worked on their constructivist learning event and while they made their presentations.

A rubric was used to evaluate the learning experience of the pre-service teachers from their task documents which were saved onto floppy disks. Two scoring rubrics were prepared. The first one was used to assess the observation process *after* the information had been compiled from the observation checklist. The second rubric was used to assess the pre-service task documents in terms of whatever knowledge students might already have possessed about malaria.

Finally, all the pre-service teachers had to use ISCED computers to complete the constructivist learning event. The learning event that had been prepared by the researcher was presented to the pre-service teachers at the beginning of the research study. The pre-service teachers were required to apply whatever computer skills they might possess in conjunction with what they knew about malaria in Lubango, Angola, to complete the learning task.

All the presentations and interviews that were conducted at the research site were video-recorded and the cassettes were later used for transcription and analysis. In this study an interpretive data analysis method was used to analyze all the data that had been collected.

1.7 Significance of the study

This study was undertaken because it could provide relevant and useful information for curriculum developers, the Ministry of Education, and the ICT teachers and coordinators about the possible use of computers in teaching and learning situations in classrooms. The findings from the study should be useful when changes are made to the curriculum at some time in the future.

1.8 Related studies

This research drew on the literature to provide examples of how computer programs had been used in pre-service teacher education. I specifically examined emergent national standards in the field as well as various exemplary programs from the literature. I also reviewed various journal articles and books that describe and support a constructivist and behavioural view of teaching.

The theoretical framework that supports this study is the theory of constructivism proposed by Bruner (1966). The analysis of the results were based on Cronje's Model of The Four Quadrants of Teaching and Learning (2000) which provides a taxonomy of the major theories of teaching and learning by placing them in four contrasting and interactive quadrants. In terms of this model, objectivism is posited as the polar opposite of constructivism. Related studies are tabulated in Table 1.1 below. These research studies are relevant to this study because their purpose was to investigate and describe how computers influenced teaching and learning in the context of pre-service teacher training.

Table 1.1: Related research studies in constructivism and technology

Author	Year	Research details	Short description
Mrwetyana, N.	1994	The preparation of pre-service teachers in colleges of education in the former Ciskei, with special reference to technology in education: a qualitative-naturalistic investigation. This thesis was presented in the Department of Education at the University of Natal for the degree of Doctor of Philosophy.	This study investigates how well prepared a select sample of pre-service teachers were to use technology in their educational practice. It also contextualises and interprets the findings in the socio-historical setting on South Africa.
Albion, P.R.	2000	Interactive multimedia problem-based learning for enhancing pre-service teachers' self-efficacy beliefs about teaching with computers: design, development and evaluation. This thesis was presented at University of Southern Queensland for the degree of Doctor of Philosophy.	This study investigates what form of professional education might be effective for preparing pre-service teachers to integrate computers into their teaching. The researcher proposes that interactive multimedia using a problem-based learning design (IMM-PBL) could be effective for increasing self-efficacy.
Sadera, W.A.	1997	Pre-service teachers' preconceptions about the role of the computer in learning and teaching. Master's degree in Science Education from Iowa State University.	The purpose of this research study is to examine pre-service teachers' preconceptions about the role of the computer in learning and teaching and the factors that affect those preconceptions.
West, R.E.	2005	Using life modelling to train pre-service teachers to integrate technology into their teaching. Master's degree in Science from the Department of Instructional Psychology and Technology at Brigham Young University.	This thesis uses a qualitative research method to deduce from the perceptions of a sample of former students of the course how students generally are affected by the method of live modelling. The researcher also suggests strategies for improving modelling and explains how one may recognise when modelling is not effective. In general this study concludes that modelling is perceived by most students to be effective for teaching technology skills and for generating creative ideas about how teachers might integrate technology with their teaching.
Bigatel, P.M.	2004	Exploring the beliefs and attitudes of exemplary technology. Presented for the degree of Doctor of Philosophy at Pennsylvania State University.	This study undertakes to describe what exemplary technology would be in terms of teachers' beliefs and attitudes about teaching, learning, and the use of technology in education. It also elucidates the process by means of which these beliefs and attitudes are formed, and how they are influenced and affected by many contextual factors in school culture. In this study, exemplary technology-using teachers are defined as those who effectively integrate technology into their instructional practices in K-12 educational contexts.

Table 1.1 shows examples of empirical research that utilised samples of pre-service teachers to conduct research in the field of constructivism and technology.

1.9 Definitions of terms used in this study

The terms below are explained briefly in Table 1.2.

Table 1.2: Terms used in this study

Term	Meaning
Theory of behaviourism	The actions that people take in response to whatever happened to them in their past. Skinner suggested the term "operant conditioning". Operant conditioning occurs when an organism's behaviour (response) is controlled by the use of positive reinforcement (White, 1995).
Theory of constructivism	An active process in which students construct new ideas or concepts on the basis of their current or past knowledge. The students select and transform information, construct hypotheses, and makes decisions on reliance on their cognitive structure Bruner (1966).
Cooperative learning	Cooperative learning is a teaching strategy in which small teams, each of which contains students with different levels of ability, use a variety of learning activities to improve their understanding of a concept or subject (Webb 1987, p. 193).
Individual learning	Individual learning means the capacity to create knowledge by means of individual reflection on external stimuli and sources, and by means of the personal re-elaboration of individual knowledge and experience in the light of interaction with others and with the environment (Sinitsa, 2000, p. 20).
Learning theory	Learning theory is concerned with definitions of learning, and with the description and analysis of theories of learning. It also condenses, summarises and distils the laws of learning and information about learning. Another definition of learning theory is a creative attempt to explain what learning is and why it works as it does (Dunn, 2000, p. 8).

1.10 Preview of the study

The structure of the study is divided in to five chapters as explained below. See Table 1.3.

Table 1.3: The structure of the study in terms of its five chapters

Chapters	Description
1. Introduction	This chapter describes how pre-service teachers at ISCED are being prepared to use computers in their future teaching. This chapter further describes how the researcher presented a constructivist learning activity to a sample of pre-service teachers. The data acquired from the learning activity and from interviews with students was used (1) to elucidate the current status of their computer skills and (2) to assess how well prepared they were for integrating the use of computers into their own teaching once they had graduated.
2. Literature review	This chapter reviews the literature about the use of computers in the teaching and learning process in the preparation of pre-service teachers. The following issues

	are discussed in this chapter: Bruner's constructivist learning theory, instructional principles, a background to and description of behaviourism in relation to learning, cooperative learning, individual learning, the role of computers in the classroom, components of computers, the theoretical framework, pre-service teachers and the use of technology.
3. Research methodology	This chapter explains the methods that the researcher used to investigate how computers were used in the constructivist learning event. The research sample comprised pre-service teachers in the Faculty of Education at ISCED in Lubango, Angola.
4. Findings	This chapter reviews the data and how it was analyzed. The data itself was obtained from a sample of pre-service teachers who were following the Computers for Education course at ISCED in Angola. The instruments used included questionnaires, interviews, an observation checklist, a constructivist learning event and scoring rubrics.
5. Conclusion	This chapter discusses various learning theories, and gives special attention to behaviourist and constructivist learning theories. It also reviews the main issues relating to teaching and learning processes in schools and institutions. The learning theories concerned help us to understand the process of learning and the instructional methods that are most effective in the teaching process.

Chapter 2
Literature Review

2.1 Introduction

Jones and Mercer (1993, p. 19) explain that modern teachers face a number of challenges as they undertake the often arduous process of integrating technology into their classroom teaching routines. Many of these teachers, if not most of them have no clear idea on how to use computers in their classrooms or how to organise and manage technology-integrated classrooms. Teachers need skills and training of a very definite kind before they are fit to integrate technology with learning in the current classroom context. Because behaviourist and constructivist theories of learning are usually used to describe how individuals succeed in learning, they have become the basis upon which a more learner-centred type of instruction process has been constructed. Jones and Mercer (1993), therefore, characterize these theories of learning as "ways of describing how people learn in terms of their individual thoughts and actions and how an individual adapts to the complexities of the society in which they live and operate" (Mercer, 1993, p. 19).

My purpose in this chapter is to review and examine research that describes how computers have been used in the teaching and learning processes to equip pre-service teachers in teacher training colleges to become skilled in techniques of integrating technology was learning in classrooms. In the process, I will also discuss some of the following issues that are relevant to this theme:

- Constructivism and behaviourism as learning theories
- Cooperative learning and individual learning
- The role of computers as the dominant form of technology in the modern classroom
- The needs and imperatives that complex forms of technology such as the computer impose on teacher training programmes
- The theoretical framework – Bruner's (1966) constructivism theory and Skinner's behaviourism
- Problems encountered by pre-service teachers as they attempt to integrate this kind of technology into their teaching practice
- Problems encountered by in-service teachers as they struggle with computer-handling skill deficits
- The implication of skill deficits among teachers all kinds for learners and for the education system in general.

2.2 Learning theories

According to Dunn (2000, p. 8), learning theories help us to understand how learning takes place; they enable us to understand the process of learning. Therefore those provide us with a basis for analysing, discussing, and doing research in the field of learning and practice. A good learning theory will also summarize a large amount of information about the rules of learning in a fairly small space. A learning theory may also be regarded as a creative attempt to explain what learning is and why it works as it does. The two learning theories that I will compare in this chapter are constructivism and behaviourism.

A survey of the literature indicates that most researchers in the field of education proceed from the basis of constructivist (rather than behaviourist) premises about "the nature of human learning and the conditions that best promote the varied dimensions of human learning" (Applefield, Huber, & Moallem, 2001, p.38). What is evident in this field is that there has been a wholesale movement away from pre-designed forms of instruction that are essentially behaviouristic to modes of teaching and instruction that are essentially constructivist (Cooper, 1993, p.14).

According to Pechman (1992, p. 34), the efforts of many professional groups to reform classroom instruction is an indication that constructivism currently exerts a decisive influence over modern education. Among professional groups who are active in these attempts to transfer form classroom instruction are the Association for Supervision and Curriculum Development, the National Council for Teachers of Mathematics, and the American Association for the Advancement of Science. Each of these groups in its own way has been influential in reforming traditional modes of instruction and implementing what are in essence constructivist modes or "active, inventive instruction".

The current literature shows that constructivism has acquired enormous prestige in the field of teaching and learning theory. It is believed that behaviourism has largely fallen from favour among concerned academics and researchers because behaviourists believe that "knowledge of the world exists independently of the learner. [It] then … becomes internalized as it is transferred from the external reality, the teacher, to an internal reality, the learner" (Driscoll, 1994).

In contrast to this, constructivism as a theory proposes that the "learner's conception of knowledge is to be derived from a meaning-making search in which learners engage in the process of constructing individual interpretations of their experiences" (Applefield et al., 2001, p. 37). This paradigm shift has affected the outlook of a whole generation of practising teachers and instructors, and it now seems natural to focus on what Applefield and others call “the meaning-making search” in which both teachers and learners are engaged. This, essentially, is what happens when constructivism is applied in practice.

I was powerfully motivated by my understanding of constructivist theory to engage in this research. I hope to be able to construct and apply constructivist learning events in pedagogical situations while, at the same time, investigating the kinds of teaching and learning processes that are used to prepare pre-service teachers at the ISCED.

2.2.1. The theory of constructivism

Hein (1991, online) defines constructivism in the following way: "Constructivism is a theory based on observation and [the] scientific study of how people learn. It says that people construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences." Whenever we are confronted with information or facts about life, we are faced with the necessity of harmonising our new knowledge and experience with everything that we have understood and believed up to that point.

Whether we are conscious of it or not, this is essentially a constructivist attitude in practice. New knowledge, new data, new experiences, all confront us with a challenge of integrating what is new with what we already understand and believe about life and the world in general. Faced with the challenge of the new, we may draw back and retreat from what disturbs us and try to rationalise it or explain it away, or we may reflect on our new experiences and integrate them into our old patterns of understanding, thereby changing such old patterns (and ourselves) in the process. Observation shows us that learners engage (whether consciously or not) in the constructivist process all the time. They ask questions, they explore, and they assess what they know in terms of their previous knowledge and assumptions. In the process, they make new discoveries and learn new things. In other words, they construct new meanings and harmonise these new meanings with what they already believe and assume to be true (Hein, 1991, online).

Jonassen, Davidson, Collins, Campbell and Hagg (1995) acknowledge the constructivist approach to instruction as a theory that requires an understanding of how students create meaning. Since the creation of meaning is central to constructivist theory, it is vital for us to understand how this process takes place. The more successful teachers are in facilitating and encouraging meaning-construction activity in their pupils, the happier such pupils will be, the more successful they will be, and the more successful the teacher will be as a teacher. If learning environments are to be places where pupils can confidently and safely expand their abilities and fulfil their aspirations, it is necessary for classrooms to become places in which knowledge construction is promoted and encouraged in an atmosphere of mutual respect between teacher and learner (Jonassen et al., 1995, p. 17).

The constructivist view is therefore that teaching is not a mechanistic or deterministic method or process of transferring knowledge from the mind of the teacher to the minds of learners. Constructivism is rather that process by means of which the teacher creates the kind of ambience and environment in which learners feel safe enough to become meaning-constructing partners with the teacher in the quest for knowledge, mastery and self-actualisation. Constructivist learning is therefore a process in which learners construct their own meaning from their own experience: what they experience guides them to make meaning out of what they have understood.

Hein (1991, online) concurs with the theory of constructivism. He understands constructivism to mean that learners construct knowledge and meaning for themselves, both individually and socially, while they learn. Learners utilise their own epistemological structures and pre-existent beliefs to extend their knowledge and process new information. Cobb (1994, p.4) points out that "constructivism stems from the idea that learning is a 'constructive process where students do not passively receive information but instead actively construct knowledge as they strive to make sense of their worlds'".

According to Dewey (1938), learning should be driven by cognitive dissonance as learners are confronted by new experiences and ideas ─ and not by reinforcement (as with behaviourists). Dewey believed that this kind of traditional (behaviouristic) reinforcement of information results only in superficial learning because it does not require learners to engage all aspects of their understanding will bring various higher order abilities into play. An educator is therefore responsible for creating learning events in which learners are presented with problematic situations which they are then required to solve by extending their pre-existing epistemological assumptions.

Bruner (1996) states that "in constructivism, learning is an active process in which students construct new ideas or concepts based upon their current or past knowledge". (Bruner, 1996, p. 20) also says that "students select and transform information, construct hypotheses and make decisions [by] relying on their cognitive structure". He adds that although the constructivist "theory of learning [had] existed for over a hundred years now, it has not been widely accepted or applied in many public schools" (Matusevich, 1995, p. 1) ─ a point that we noted earlier. By the beginning of the 21st century, constructivism has become (as we have already suggested) the theory of choice in most progressive educational schools. Both Dewey and Maria Montessori were advocates of constructivism in their day, as were Jerome Bruner and, in more recent years, Vygotsky (Campoy 1992).

Constructivism supports learner-centred instruction because it advocates that "learning environments should have multiple perspectives or interpretations of reality, knowledge construction, context-rich experienced-based activities" (Jonassen, 1991, p. 10-11). Constructivism advocates a learning environment in which learners are specifically encouraged to draw on their previous experience, knowledge and understanding to construct new knowledge rather than to reproduce (by means of rote memorisation and regurgitation) old forms of knowledge or dogma. Constructivism assigns no specific value to virtuoso feats of memorisation as the most important criterion for defining success. In a constructivist learning situation, knowledge and information are nearly always supplied to learners in the form of reference sources. The sources are easily accessible and retrievable printed matter, pre-selected text, books and electronic files, as well as referenceable CD-ROMS or DVDs, photographs, videos and other forms of electronic information.

What is of interest to the constructivist educator is not how readily the learner is able to access necessary information, but how skilfully the learner is able to process the information as he or she goes about solving authentic problems. The educator identifies or problems tasks that are suited to learners' levels of skill, expertise and understanding, and then invites learners individually and as a team to find appropriate solutions (Jonassen, 1991, p. 10-11). Ferguson (2001, p. 47) therefore claims that the central idea of constructivist theory is that all useful learning is constructed from prior knowledge. There is also a strong emphasis in constructivist learning on the augmentation of communication, social and dialogue skills by means of practice (i.e. being able to communicate effectively with one's teachers and peers).

Teachers themselves are encouraged to facilitate rather than inform so that learners become people who discover rather than passive consumers who accept without question the opinions of authorities. Teachers thus engage in constructive dialogues with learners, not because they are all knowing or even because they possess the necessary information to solve the problem in hand, but because they are trained to present the problem in a way that takes into account what their learners already know and what the conditions are that will challenge learners to move to the next level of knowledge and expertise. Constructivist learning is therefore often presented in terms of the metaphor of a spiral in which learners make successive iterations as they advance to new levels of knowledge. In doing this, what learners know "increases [in] content complexity and synthesis level" (Bruner, 1966).

The following constructivist principles (as they are worded below) were proposed by Ferguson (2001, p.48), and were endorsed in various forms by Jonassen (1991), Wilson and Cole (1991), Ernest (1995) and Honebein (1996). It is the collective wisdom of these authorities that the following recommendations need to be accepted and applied if one hopes to use technology successfully in a constructivist classroom:

- Create "real-world" environments in which learning is relevant
- Focus on solving real-world problems
- Use instructors as guides
- Provide learner control
- Negotiate instructional goals with students
- Use evaluation as a self-analysis tool
- Provide the necessary conceptual tools to help learners to interpret different perspectives
- Ensure that the learner is controlling and mediating learning internally
- Provide multiple representations of reality
- Focus on knowledge construction, and not reproduction

(Ferguson, 2001, p. 48).

Each of these principles has implications for the use of technology in the classroom. Ferguson writes: "A constructivist technology-integrated lesson plan should be designed to bridge the transition between teacher-led instruction and self-directed learning by students" (Ferguson, 2001, p. 49). She cites evidence (referred to above) that confirms that belief that there is a direct relationship between the use of computers in classrooms and a measurable decrease crease in teacher direction of learners. The more extensive the use of computers, the more *constructivist* does a classroom-based learning situation become.

Bruner (1996) suggests the following didactic instructional principles that make constructivist teaching and learning even more effective:

- Instruction must be concerned with the experiences and context that make the student willing and able to learn
- Instruction must be structured so that it can easily be grasped by the students
- Instruction should be designed to facilitate extrapolation or fill in the gaps
- The instructor should try [to] encourage students to discover principles by themselves.

Because learners come from different social and ethnic backgrounds, they bring unique gifts, talents and knowledge to the constructivist learning context (Southwest Educational Development Laboratory, 1995). If learners are not to be inhibited by their differences, learning situations need to be firmly based on constructivist principles. This implies an ability on the part of learners to share without undue shame, shyness or inhibition in team situations or when working with partners. It also implies that teachers are in agreement with the following constructivist ideas, premises and principles, and are able to integrate them into their day-to-day practice:

- Knowledge is constructed uniquely and individually, in multiple ways, through a variety of tools, resources and contexts
- Learning is both an active and reflective process
- Learning is developmental
- We make sense of our world by assimilating, accommodating or rejecting new information
- Social interaction introduces multiple perspectives on learning
- Learning is internally controlled and mediated by the students

(Southwest Educational Development Laboratory, 1995).

2.2.1.1 Shifting roles in a constructivist classroom

Mann (1994, p. 174) is of the opinion that one can attribute the popularity of constructivism in the past few decades to novel forms of technology such as computers in classrooms. These new technologies include computers in schools and in teacher training colleges. Such technological resources, in combination with the Internet, empower

learners by giving them opportunities to work on "real-life" activities and to solve authentic problems. Any practising teacher will be able to testify to the fact that access to the Internet has transformed the classroom landscape. Learners now have access to infinitely more information than was available to their mothers and fathers in the classrooms a few decades ago.

It is possible that learners of past generations were expected to memorise clearly defined fixed forms of knowledge that their teachers provided. The exact forms of this knowledge were clearly delineated in a rigidly defined "syllabus" and no deviance from the syllabus was ever tolerated. But with the advent of computers, it is not knowledge or information that is the issue. Knowledge and information are freely available to anyone who has access to the Internet. The real problem now is for learners to make informed decisions about what information might be relevant to the problem that they need to solve. Mann (1994, p. 172) points out what we all already know when she emphasises just how vast of a data banks on which anyone who is connected can draw.

Modern learners therefore need to become skilled in information management rather than traditional memory skills. They also need to become adept at communicating with those who possess the kind of understanding that is necessary to interpret the sheer volume of information that is so readily available to users of the Internet. In a technology-rich environment, the education process has to focus on the learning itself, as well as on the instructional goals of participant teachers and the school system at large.

Technologies alone do not answer. Campoy (1992, p. 17) asserts that technologies in themselves are "merely tools or vehicle calls for delivering instruction". In these circumstances, it is evident that it is not the form of technology itself that guarantees success. Successful negotiation of obstacles and problems depends on *how skilfully* the technology is used ─ not to mention the human gifts and talents that the learner who is using the technology brings to the solution of problems. Strommen and Lincoln (1992) emphasize that what counts more in a constructivist classroom is what students can do *by themselves*, either under the guidance of the teacher or individually, as they use the new technologies.

Campoy (1992) cites studies that identify the kind of observable differences between a constructivist classroom and a traditional classroom. Campoy notes that in a constructivist classroom, one might observe that:

- There is a discernible shift away from whole-class instruction towards small-group instruction
- The teacher, instead of lecturing, coaches, orientates, inspires and debates
- Teachers work more frequently with weaker students rather than focusing attention on brighter students (as is the case in traditional settings)
- Learners abandon their passivity and become more actively engaged
- Students become more cooperative and less individually competitive
- Visual and verbal thinking ─ rather than primary verbal thinking ─ become more evident among learners

(Campoy, 1992, p. 17).

In the constructivist classroom, modes of technology are there to be used by learners in activities that involve self-expression, exploration, synthesis, negotiation, collaboration and reflection. Modes of technology therefore become the *means* that learners use to express themselves creatively in the classroom. Technology, as such, has no intrinsic value. It is the *uses* to which technology is put that determines the quality of teaching and learning in a constructivist setting. Constructivism more accurately reflects the way in which we as human beings learn new skills and abilities, as well as the ways in which we acquire new knowledge and expertise. Human beings learn by doing, by acting, and by purposeful communication with significant others (Southwest Educational Development Laboratory, 1995).

2.2.1.2 Assessment in a constructivist classroom

Jonassen (1991a, p. 32), quoted in Matusevich (1995), states:

> "Perhaps the thorniest issue yet to be resolved regarding the implications of constructivism for learning is how to evaluate the learning that emerges from those environments. If constructivism is a valid perspective for delivering instruction, then it should also provide a valid set of criteria for evaluating the outcomes of that instruction. That is, the assumptions of constructivism should be applied to evaluation."

Jonassen (1991a, p. 32) makes the following thirteen assertions about assessment and other matters in the constructivist classroom:

- Technology can and will force the issue of constructivism
- Assessment will have to become outcome-based and student-centred
- Assessment techniques will have to reflect instructional outcomes
- "Grades" must be contracted wherever grades are required
- There must be non-graded options and portfolio assessment
- Self-evaluation and peer-evaluation should be carefully and thoughtfully balanced with teacher assessment
- Performance standards that are easy to apply in practice need to be developed
- A grading system must be developed which provides meaningful feedback
- Technology can be used to facilitate communication with parents
- Videotapes of learners working should be included as part of their portfolio
- The focus should be on originality and appropriate performance rather than on regurgitation
- It is important to evaluate how the learner goes about constructing his or her own knowledge rather than to focus exclusively on the end-product
- Assessment is context dependent

(Jonassen, 1991a, p. 32).

The expanding use of technology in schools reflects an ever-increasing dependency on technology in society at large. Because most young people from affluent families grow up in technology-rich households, the extension of their skills to the management of technology in classrooms is a natural step for modern learners from privileged communities. Mann (1994) observes that many educators who were themselves educated in traditional classrooms have been slow to recognise the potential of various modes of technology in the classroom. Campoy (1992, p. 17) writes: "Many educators, as well as members of the general community, are naive about the ramifications of technology implementation, and proceed without a clear understanding of both the role of technology in schools and what are reasonable expectations." This fairly describes the current situation in Angola, and at the ISCED in particular, where the potential role of technology is ignored by many teachers.

2.2.1.3 Constructivist teachers and their roles in the classroom

Lunenburg's opinion (1998) the constructivist philosophy of education encourages us quite naturally to adopt certain teaching practices. The most important of these practices is that teachers encourage learners to experiment, to take risks, to communicate with one another and with experts in the field, and to extend the range of their knowledge as they cooperate to solve the problems by which their success in learning will be assessed. The constructivist philosophy also encourages reflection and consultation as learners review what they have achieved and what they hope to achieve at various stages of problem-solving activity. A constructivist teacher is especially interested in dialogues and consultations of this kind because they reflect more accurately than any written examination could do the kind of skills those learners have mastered as they achieve mastery over their environment. A constructivist teacher is an interested but non-directive listener who ideally remains "invisible" even as he or she draws informed conclusions about the quality of group work, about levels of participation, and about the qualities that individual learners bring to the task in hand. Lunenburg (1998) asserts that it is absolutely necessary for teachers to have a clear understanding of the pre-existing knowledge and skills that learners bring to bear in the learning activity.

Brooks and Brooks (1993, p. viii), quoted by Lunenburg, (1998, p. 77), maintain that a constructivist teacher will:

- Pose problems of known relevance to students
- Structure learning around primary concepts
- Seek and value the points of view of his or her learners
- Adapt the curriculum so that it supports the suppositions of learners at the stage of intellectual development at which they find themselves
- Assess student learning in the context of teaching.

Lunenburg (1998, p. 78) asserts that constructivist teachers are comfortable with learner autonomy, independence and displays of initiative. This is one of the main differences between the traditional classroom and the constructivist classroom. To a superficial or intimidated observer, the constructivist classroom may appear to be both chaotic and

disordered. But an informed observer will detect characteristic signs of constructive learning in the apparent chaos, noise, excitement, contradiction and displays of personal energy and enthusiasm in the context of group work and teamwork.

The traditional class, in contrast, assigns its greatest value to precisely the opposite qualities. The qualities most valued in traditional classrooms include silence, stillness, inaction, passivity, conformity, similarities rather than divergences in appearances and manner, self-effacement self-abnegation and surrender of personal autonomy. In the constructivist classroom, the teacher encourages personal responsiveness, initiative and makes it clear that engagement rather than passivity is what is most valuable in group work. He or she also makes it clear that learners can expect to be assessed and evaluated for the contribution that they make ─ rather than their silence, non-engagement and inactivity. In the sense at least, the constructivist teacher is not an impartial observer. The teacher remains very clear about what is most expected in learners as they engage with authentic learning tasks. The constructivist teachers' hopes and attitudes are determined by the implicit expectations of best-practice models of constructivist learning.

Airasian and Walsh (1997) agree that constructivist teachers are responsible for creating the kind of sympathetic environment in which learners will not feel judged, exposed, criticised or humiliated as they take the initiative in group, personal or team learning situations. Taking the initiative implies self-disclosure. And self-disclosure is the basis of all creative activity. Constructivist learning therefore is categorically similar to other forms of creative activity and often indeed includes them. But self-disclosure is an inherently risky process. To disclose one means to open oneself to the potentially hostile scrutiny of one's peers and one's teachers. It follows therefore that the constructivist teacher is someone who is comfortable with the self-disclosure and initiatives of others. A constructivist teacher needs therefore to be expert in non-directive intervention. He or she would be someone who believes in the educational value of encouragement, enthusiasm, personal warmth, tact, challenge, and professional self-effacement (where appropriate) for didactic purposes. Such personal qualities that would most certainly have condemned the constructivist teacher to professional oblivion in the traditional classroom. The constructivist teacher is also someone who is comfortable with ambiguity, with the kind of tentativeness or "imperfection" that is characteristic of all learning processes, and with a great number of sometimes contradictory responses which is to say that there is often no one correct solution to many of life's problems.

2.2.1.4 The role of learners in a constructivist classroom

Brooks and Brooks (1993) have emphasised that learners are not "blank slates" (tabula rasa) upon which knowledge is imprinted. Learners approach each new situation in life with pre-existent knowledge and assumptions which, in turn, become "raw material" for the new epistemological syntheses that they will create. Brooks and Brooks (1993, p.103-118) are of the opinion that a constructivist teacher is someone who will:

- Encourage and accept student autonomy and initiative
- Demonstrate to students the contradictions that may be embedded in initial understandings and formulations of situations or problems, and then encourage questions and discussion
- Provide time for students to construct relationships and create metaphors
- Assess student understanding by means of the application and performance of open-structured tasks
- Encourage students to engage in dialogue with their teachers and with one another
- Assemble a wide variety of materials, including raw data, primary sources and interactive materials, and encourage students to use them
- Ask students what *they* understand by concepts before they share their own understanding of such concepts
- Encourage student inquiry by asking thoughtful, open-ended questions
- Encourage students to question one another
- Encourage students to elaborate on their initial responses and formulations

Brooks and Brooks (1993) compare learners to detectives. They use this metaphor because detective is someone who solves problems by the intense application of his or her critical faculties to a particular problem. The detective is somebody who is constantly alert to inconsistency, incompatibility and incoherence in stories and in situations. He or she scrutinises human behaviour, asks questions, interviews witnesses, checks records and data banks, and follows promising lines of investigation. The activities of the detective are metaphorically parallel to those of the learner as he or she comes to grips with authentic problems, solves tricky problems, and creates higher syntheses of pre-existent knowledge.

The metaphor of the learner as detective is especially apt because the learner is someone who learns to weigh and assess evidence as part of a process of creating a new synthesis of knowledge that explains facts that were inexplicable in terms of the old synthesis. Ideally, a learner, like a detective, becomes adept at scanning sources of information such as newspapers, telephone books, the Internet, and various public and private databases for information that is relevant to the problem that has to be solved. The constructivist learner is, like the detective, far more concerned to use his or her critical faculties to create a new synthesis rather than to memorise texts and some forthcoming ordeal (such as an examination or court appearance).

2.2.1.5 Empirical studies based on constructivist learning theory

Although innumerable studies and a great deal of research have been based upon constructivist learning theory, I shall, at this point, mention only two such studies. The first was undertaken by Richards of Winthrop University, South Carolina in 1998. The students whom Richards assembled to undertake constructivist literacy research were required to utilise only electronic technology to accomplish their goals. Each of the participants was asked to compile an electronically formatted portfolio from a list of topics relevant to literacy studies. These portfolios were expected to reflect how students

had discriminated between relevant and irrelevant data, how they had assembled evidence to support the contention of the chosen theme or topic, how they had constructed arguments that supported their contentions, and how they had marshalled their data and arguments in a coherent and convincing electronic technological form. Participating students were then expected to share their conclusions with their fellow students and teachers.

The activities of the participants included "collaboration and cooperation in a group engaging in problem solving and constructing potential solutions to societal dilemmas, [..] communicating the deeper processing of content and the critical development of literacy skills and strategies" (Richards, 1998).

Another study conducted by Walker (2000) from the Open University in the United Kingdom purports to demonstrate how constructivist forms of teaching and learning may be enriched and enhanced by the increasing integration of technology in the classroom. The institution concerned in Walker's research had developed a distance-learning course with the purpose of helping students to be able to learn more effectively and to become more active students while constructing their own understanding. The eleven subjects in the experimental group all felt that their learning skills had been significantly improved by their participation in the study. Walker (2000, p. 236) wrote: "The development of course modules that were based on constructivist practices and the integration of technology were also beneficial to the faculty. This resulted in changing the faculty plans by integrating technology for students to become more efficient by the use of application skills."

2.2.2 Theory of behaviourism

B.F. Skinner (1977) was perhaps more than any other person in modern times responsible for popularising the behaviourist approach to research. Behaviourism, which was immensely influential popular between the late 19th century and the years preceding and following the Second World War, attempted to explain learning in terms of explanations and models that emphasised the automaticity of specific kinds of human learning. Skinner's limitation is that he extrapolated from this kind of mechanistic learning (which is indeed valid in its own very limited context) to higher forms of human learning and synthesis construction which cannot be explained in terms of the simple deterministic model on which behaviourism is based.

Skinner developed his theory from, among other sources, the experimental work of Ivan Pavlov (1849-1936) for his theory of conditioned reflexes, research for which Pavlov was awarded the Nobel Prize in 1904. Arends (2001) maintains that it is the purpose of schools to inculcate knowledge and instil values by means of conditioning which, in practice, translates into a system of rewards and punishments. A behaviourist approach for equipping students with academic knowledge and skills and for developing character would rely on classical conditioning techniques such as reflexive aversion in the form of punishments or sanctions rather than on encouraging exploration, initiative and self-reliance. The behaviourist classroom also emphasises the importance of respect for

authority, perseverance, commitment to duty, consideration for others and practicality. While each of these values is desirable in itself, one does not need to use specifically behaviourist techniques to evoke them in learners. It will be clear from this analysis that behaviourist techniques of learning (such as drill, frequency and repetition) would be more useful in some subjects (such as mathematics and the learning a foreign languages) than they would be in others (such as history and literature) in which the exercise of critical faculties, the assessment of evidence, questioning and ambiguity, and learner initiative are crucial).

Gover and Gavenk (1995) state that traditional behaviourist classrooms are mostly teacher-oriented. In such classrooms, teachers serve as intellectual and moral role models for the learners. The teacher's role in a classroom of this kind is to demarcate very precisely everything that learners need to learn. One of the roles of the teacher in a traditional behaviourist classroom is to maintain the boundaries between what is "in the syllabus" and what is "not in the syllabus", and to ensure that impermeability of these boundaries. The behaviourist teacher therefore becomes a referee and an authority on what is valid knowledge and what is irrelevant and impermissible in terms of the syllabus. It is one of the teacher's duties in the behaviourist classroom to ensure that the interest and enthusiasm of learners will be very strictly and carefully monitored so that it does not spill over into areas of human knowledge and achievement that are not in the "syllabus".

It is precisely for these reasons that the traditional teacher is responsible for curtailing learners' freedom and initiatives. Enthusiasm may not be encouraged because enthusiasm is bound to lead into areas of interest and modes of inquiry that are not sanctioned by the syllabus. The maintenance of boundaries (as defined by the syllabus) is overwhelmingly important in the traditional behaviourist classroom. Conformity, rigidity, obedience, acquiescence, passivity and blind single-mindedness are all values that are encouraged in the behaviourist classroom. When it comes to evaluation, the teacher is responsible for compiling numerical scores that reflect each learner's competence in the skills customarily prized in the behaviourist classroom. Among such skills, the ability to memorise and reproduce facts in close-ended written examinations, and other feats of memorisation such as the recitation of linguistic paradigms in language acquisition, rate very highly indeed. The essentialist classroom focuses on teaching learners an authorised version of knowledge about the people, events, ideas and institutions that have shaped society ─ a version that has been sanctioned by the appropriate authority (often the state itself).

2.2.2.1 Behaviourism and learning

Thorndike (1926) emphasised behaviourism as "a description of a man's mind that it is his connection system, adapting the responses of thought, feeling, and action that he makes to the situation that he meets". Thorndike also posited what he called "the law of effect" and "the law of exercise", and how these affect a human being's ability to learn. Thorndike play down the role of punishment in learning and chose instead to emphasise the beneficial effects of positive reinforcement and repetition. White (1995) also

confirms the behaviourist principle that states that the more frequently a particular response mechanically follows its stimulus in the learning situation, the more entrenched and embedded does the learning become.

Skinner himself (1977) believed that human behaviour is always a response to learned conditioning from the past. If this is true, then all human behaviour is indeed conditioned and determinism is the only possible source of human knowledge. Skinner attempted to soften the harshness of this deterministic model of human behaviour by elaborating on his concept of "operant conditioning", in which a strong emphasis is placed on positive reinforcement rather than crude notions of mechanistic reward and punishment (White, 1995).

Gagne and Bloom (quoted in White, 1995) further elaborated on behaviourism. Gagne uses the concept of "task analysis" as the counterpart to Skinner's notion of "sequenced learning events". In task analysis, the learner reinforces learning by reacting to feedback on his or her performances. Bloom extended the basic Skinner model by proposing that learners be given whatever additional time and instruction they would need to fix their learning (White, 1995). Traditionalists have tended to take from Skinner what most suits their assumptions. What they find most useful and sympathetic in Skinner is his assertion that patterns of behaviour can be strengthened by positive and negative reinforcement. Positive and negative reinforcement translate without much difficulty into the traditionalist reliance on reward and punishment which are mainstays of traditionalist modes of learning.

White (1995) affirms the following sequence of events that constitute behaviouristic teaching:

- Set behaviour goals
- Determine appropriate reinforcements
- Select procedures for changing behaviours
- Implement procedures and record results
- Evaluate progress
- Revise as needed.

2.2.2.2 Behaviourism and technology

Although behaviourist techniques are widely used in certain kinds of education in which "the emphasis [is on] behaviour, drill-and-practice methods, and methods for breaking habits, reinforcement or rewards" (Ormrod, 1995, p. 196), there are a number of assumptions implicit in behaviourist philosophy that I will now discuss in more detail.

The first assumption is that learners should be carefully controlled and regimented at all times, and that they should be subjected to carefully defined learning situations in which their behaviour is strictly regulated. Ideals of what are "acceptable" forms of behaviour

for learners in behaviourist learning situations all tend to follow the same basic pattern. In such situations learners need to be strictly controlled because the learning situation that is imposed upon them requires a great deal of organisation, planning and effort. Because the behaviourist learning event has to be *imposed* upon learners, the learners themselves have to be trained and conditioned to receive it. If learner behaviour is not strictly regulated, the appropriate forms of positive and negative reinforcement cannot be efficiently applied and learning (behaviourist learning anyway) will not take place. It follows therefore that learners should be *visible and accountable* at all times, that they should not be engaged in private or even team learning tasks without proper sanction and authority, and that they should at all times conform to the outer signs of an inner acquiescence and malleability (such as uniforms, timetables, modes of address, observance of the sanctity of ritualistic spaces, conformity with institutional norms of self-presentation, and appropriate forms of behaviour).

The second assumption is that the success of a learner in the educational system can be measured by his or her ability to reproduce memorised facts and information in mainly written examinations (and, in more modern times, in mechanistic multiple-choice questions that are assessed and ranked electronically). In such circumstances, creativity, independence and initiative would, at best, be praised in theory but definitely not encouraged in practice. At worst, it would be construed as evidence of maladjustment to traditional values and (for purposes of assessment) be regarded as the pretext for failing to achieve academic mastery.

In the behaviourist classroom, the evidence for learning is approved behaviour, which, in the class anyway, means achieving higher scores in tests, examinations and drills (Ormrod, 1995, p. 198) In the behaviourist classroom, the *action* that the learner takes (the learner's response) in response to the stimulus (the teacher's didactic input) is all that is required from the learner. In a setup such as this, learning can only be overwhelmingly teacher-directed because the teacher alone is the guardian of quasi-sacred syllabus knowledge, familiarity with which and mastery of which alone confers academic success and honour. The inescapable counterpart of undeviating teacher direction is learner passivity, which is indeed readily observable in any properly functioning normative traditional behaviourist classroom.

A vital part of the behaviourist educational agenda is to undermine undesirable traits by creating educational situations in which learner responses are gradually superseded by more desirable responses. A behaviourist would describe this as "weakening […] the undesired behaviour by removing the reinforcing events that maintain the behaviour" (Ormrod, 1995, p. 199). In this way, theoretically at least, it would be possible to reprogram a learner's whole character and outlook by arranging for the learner to spend enough time in situations that have been specially designed to work in such a way that undesirable learner traits will ultimately be replaced by more desirable character traits. Although this hypothesis is plausible, and is the basis for much remedial teaching, it would in practice be impossible to educate a very large number of learners by applying such a method. For a method like this to work properly, teachers would have to devise,

present and implement a series of unique learning experiences, each of which would have been tailor-made for a specific learner.

Because the best-endowed educators in the world have limited resources, time and opportunities either to create or apply such a method, behaviourist techniques of this kind are irrelevant in situations where a large number of learners have to be educated. In remedial education where one teacher attends to one learner, as well as in certain kinds of drill exercises, this kind of behaviourist technique is both appropriate and useful (Ormrod 1995). But behaviourist techniques of this kind are not the sole preserve of the behaviourist teacher, and the same results can be achieved without resorting to behaviourist explanations. From constructivist point of view, a learner is not a *tabula rasa* that has to be *imprinted* with new knowledge, attitudes, and responses. Constructivists regard the learner as a self-actualising, autonomous agent who learns through intelligent and purposive *doing* in appropriate circumstances.

Behaviourists generally tend to analyse the educational milieu in terms of how well it delivers appropriate stimuli to learners. In the behaviourist analysis, the learner is always someone who is being *acted upon* rather than someone who acts spontaneously and energetically from a point of view of enlightened self-interest. While a behaviourist and a constructivist learning milieu may thus sometimes look the same to a superficial observer, the philosophical explanations that enable us to understand what is happening in the teaching and learning situation are very different indeed. Concepts such as positive and negative reinforcement and reward and punishment have radically different meanings for behaviourists and constructivists. While a constructivist educator might occasionally use behaviourist terms, his or her understanding of such terms would be totally different from that of a behaviourist educator. The difference between the behaviourist and the constructivist can be seen most clearly in the different way in which each would explain the value and purpose of techniques such as, for example, repetition in educational practice.

A behaviourist would rely heavily on reward as a means of positive reinforcement, and on sanction or punishment as a means of negative reinforcement. In the behaviourist view, desired behaviour is the end result of motivation, and motivation is instilled through primary positive reinforcements that are equivalent to the rewards that school and society bestow on those who manifest desired behaviours. These rewards constitute primary reinforcements because they are those that are most valued and prestigious in the microcosm of school which reflects the values and standards of society. Such primary reinforcements confer a great deal of status and prestige. In the behaviourist hierarchy of rewards and punishments, there is also a whole range of secondary reinforcements that teachers routinely apply as rewards for the kind of educational outcomes they are seeking to instil. Such secondary reinforcements include positive feedback on assignments, special privileges inside and outside the classroom, and specific expressions of approval for what learners do and how they perform when their behaviour conforms to institutional goals.

Ormrod (1995) asserts that when learners are consistently praised for behaviour and performances that are consistent with institutional goals, their educational performance in general and their results in particular tend to improve. Although teachers define educational goals and desired performance in terms of the syllabus, they quite often need to adjust their criteria for optimal performance and behaviour to suit individual learner differences. Ultimately, Ormrod asserts, teachers need to reduce the degree of reinforcement that they apply in educational situations so that: (1) they will have an opportunity to assess the extent to which individual learners have been properly conditioned (educated), and (2) they can give learners the opportunity to manifest desired behaviours in situations where reinforcement is absent. The ultimate goal of behaviourist education is to condition the learner in such a way that he or she will be able to display desirable behaviour and manifest appropriate outcomes even in the absence of pedagogical reinforcement.

2.2.2.3 The role of behaviourist teachers

For behaviourists, schools and other educational institutions function as the guardians and transmitters of social values and standards because they condition learners to understand the difference between acceptable and antisocial behaviours. It is when learners are young, behaviourist believe, that there are most susceptible to the kind of beneficial conditioning that will give them the opportunity of becoming valuable and productive members of society. It is in the school situation that teachers (who should ideally, in the behaviourist view, themselves be embodiments of "positive" social values) find opportunities to instil into young learners the values and ideals that are most admired by the majority of well-adjusted citizens.

Howicks (1971) accordingly summarises the role of the ideal teacher in the behaviourist classroom by asserting that such a teacher is someone who:

- prepares students for future developmental and social responsibilities
- utilises teaching methods that fall somewhere between the kind of blatant conditioning represented by traditional feats of memorization and mindless drill and the "directionless freedom of modern progressivism"
- accepts that he or she is central to the educative process
- that this centrality constitutes a *necessary* condition for the validity and soundness of the educational process
- believes that it is necessary, for educational reasons, to maintain the integrity of the educational hierarchy (with the teacher as the only ultimate authority in the classroom)
- believes that the learner can only benefit from the education provided if he or she consciously submits intellectually to the superior knowledge and authority of the teacher
- ensures that learners are kept in a receptive frame of mind by means of the application of positive and negative reinforcements
- believes in the efficacy of giving young learners a thorough grounding in basic traditional skills and subjects such as history, mathematics, science and language

- pays particular attention to the development of skills of reasoning and deduction
- strives to make himself or herself a good role model for learners
- is committed to being a resource for learners and a guide or arbiter in everyday matters
- consciously sets a good example to learners both inside and outside the classroom.

2.2.2.4 The role and function of behaviourist learners

The role and functions of learners in a behaviourist classroom is frequently misunderstood and misrepresented. It is incorrect to assume that a learner is "a passive entity that merely reacts to environmental stimuli" (Anderson, 1989). According to Skinner (1968), the learner is someone who must "play an active role" in his or her learning. Skinner asserts that learners move from one level of achievement to another by means of trial and error as they engage in learning tasks, experience new situations, and observe whether the strategies that they have been using are conducive to success or failure. Skinner believes that these three conditions (experimental reaction to success or failure, actual engagement in learning tasks, and first-hand experience of the results of action) are all necessary precursors to the sound learning and that they define whether a particular transaction between teacher and learner can be described as learning or not. When these three conditions are present, an observer is able to understand the content of a particular act of learning, to observe the way in which the learning took place, and what it is that has made the learning effective and durable. If learning is to be effective, the learner should be in a constant state of response to the stimuli provided by the teacher. The learner, in other words, can only learn effectively if he or she accepts the authority of the teacher, the inferiority of his or her own situation as someone who does not know and who needs personal guidance, and the validity of the classroom as the locus in which teaching and learning transactions take place.

2.3 Constructivism and behaviourism

Gruender (1996) denies that behaviourist theory guarantees the superiority of one particular kind of educational method over another. Gruender writes that:

> "constructivism offers its recommendations to the classroom teacher on the assumption that all learning is conscious and voluntaristic and what we need to do is engage the student in the learning adventure; while behaviourism assumes, on the contrary, that it is unconscious and involuntary and that what teachers need to do is structure the environment in such a fashion that the student would in time emit the desired behaviours" (Gruender, 1996, p. 23)

Von Glasersfeld (1987), on the other hand, asserts that the difference between constructivist behaviourist methods of learning is defined by the presence or absence of

interpretation. He writes: "In the behavioural theories, an organism is merely acting and reacting, whereas in constructivism, the organism is interpreting. Interpretation implies awareness of more than one possibility, deliberation, and rationally controlled choice." He adds that while constructivists discern learning in the learner's personal autonomy as he or she engages with learning tasks, behaviourists tend to analyse learning situations in terms of stimuli provided by the teacher and responses manifested by learners ─ a definition that tends to obscure the difference between education and training. Gruender (1996) also observes that constructivists tend to regard many other elements as being of equal importance to conditioning in the learning process. He notes that there are many constituents of the act of learning which, although they cannot in any way be described as stimuli, are nevertheless indispensable to learning.

Perhaps the most important difference between constructivist and behaviourists is that the constructivists believe that learners receive information or knowledge that needs to be *constructed* ─ while behaviourists believe that learners do not possess such knowledge. If the behaviourist model is correct, the learner cannot actually learn anything without first becoming the recipient of some kind of input from the teacher (or from sources authorised by and recommended by the teacher). Behaviour that is formulated in this way underwrites the hegemony and supremacy of the teacher and the dependence and passivity of the learner. The cumulative effect of this kind of teacher-learner hierarchy is reinforced by the assumptions, shibboleths and taboos that are observable in any traditional classroom. To traditional behaviourist educators, authority, submission, dominance and compliance are all values that are non-negotiable. These values tend to create an invisible barrier of formality that the behaviourist would regard as valuable and necessary, but which the constructivist would regard as a hindrance to the educative process.

Whereas interpersonal warmth and informality are characteristic of the constructivist classroom, the behaviourist classroom tends to be more rigid, formal and predictable. In a behaviourist classroom, the inevitable accompaniments of self-motivated constructivist learning (such as elevated noise levels and unimpeded learner movement and activity) would not be tolerated because they would be perceived as undermining the dignity and control of the teacher and the self-imposed discipline and self-control of the learner.

The most obvious differences between a constructivist and behaviourist classroom have been summarised Brooks and Brooks (2002), and are presented here in table 2.1.

Table 2.1 Differences between a constructivist and behaviourist classroom

Behaviourists classroom	Constructivist classroom
Students primarily work alone	Students primarily work in groups
Curriculum is presented part to whole, with emphasis on basic skills	Curriculum is presented whole to part with emphasis on the big concept
Strict adherence to a fixed curriculum is highly valued	Pursuit of student questions is highly valued
Curricular activities rely heavily on textbooks and workbooks of data and manipulative materials	Curricular activities rely heavily on primary sources
Students are viewed as "blank slates" onto which information is etched by the teacher	Students are viewed as thinkers with emerging theories about the world

Teachers generally behave in a didactic manner, disseminating information to students	Teachers generally behave in a interactive manner mediating the environment for students
Teachers seek the correct answers to validate students lessons	Teachers seek the student's point of view in order to understand student learning for use in subsequent conceptions
Assessment of students learning is viewed as separate from teaching and occurs almost entirely through testing	Assessment of students learning is interwoven with teaching and occurs through teacher observation of students at work and through exhibitions and portfolios

*Adapted from Brooks and Brooks (2002), http://education.ed.pacificu.edu/aacu/workshop/constructivism.html

This table summarises the most obvious differences between a behaviourist and a constructivist class.

2.4 Computers and teaching in the classroom

2.4.1 The role of teachers in a computer-rich environment

Means (1994, p. 18) and other researchers have confirmed that one of the most evident consequences of the introduction of technology into the classroom is that it changes the modes of interaction between learners and teachers. Because many learners are proficient in the manipulation of technologies such as personal computers, technology immediately creates a levelling effect on the classroom. It is pointless for a teacher even to attempt to maintain the kind of almost hieratic dignity and mystique that is characteristic of the behaviourist teacher in the face of the obvious superiority that many learners manifest when it comes to manipulating complex forms of technology such as the computer. To the behaviourist, this may be a disaster. But to the constructivist, the loosening of bonds of passivity and complacency and the learner's acceptance of personal responsibility for his or her education is an enormous dividend of a wholly constructive kind.

It seems therefore that while technology in the classroom is inimical in many ways to the behaviourist agenda, it unintentionally promotes the purposes of constructivist teaching to an almost revolutionary extent. Nothing has quite undermined learner passivity and the customary vertical lines of authority of the traditional classroom more completely than active learner engagement within the classroom with highly prestigious forms of technology such as the computer. Computer technology immediately creates a situation in the classroom in which the teacher is not the sole authority and in which learner initiative becomes not merely desirable, but indeed necessary. Navigation on a computer and successful manipulation of software *require* initiative rather than passivity, obedience, mindless respect for authority, and dependence on the superior knowledge of the teacher. But the teacher's prestige and authority are not undermined by the introduction of technology into the classroom provided that the teacher is sufficiently flexible to adapt himself or herself to modes of interaction that learners that are more democratic and self-effacing. This is both a challenge and an opportunity. While younger teachers tend to adapt themselves more easily to more democratic and centrifugal methods of instruction (usually because they themselves have often been exposed to this kind of educational

method as learners), older teachers may understandably feel threatened because (ironically) their *conditioning* has not prepared them for the kind of radical doubt and confrontation that takes place in the fully active constructivist classroom.

Fontaine describes the dilemma in which older traditionalist teachers often find themselves in the following way:

> "Teachers may be forgiven if they cling to old models of teaching that have served them so well in the past. All of their formal instruction and role models were driven by traditional teaching practices. Breaking away from traditional approaches to instruction means taking risks and venturing in to the unknown. But this is precisely what is needed at the present time" (Fontaine, 2000, p. 53).

In behaviourist classrooms of the traditional kind, teachers are at liberty (within reason) to dictate the kind of learning and classroom procedures that they prefer, and to enforce them with the authority conferred upon them by the institution and by society. Siegel (1995) asserts that the introduction of technology and constructivist assumptions into the classroom compels teachers to change their custom modes of teaching and to adapt themselves to new necessities. Many traditional teachers are distressed by the need for such adaptations because their styles and modes of teaching and interaction with learners have (once again ironically) been *conditioned* by the rigours of a traditionalist teacher education. Teachers of this kind often find it extremely arduous to adapt to the more constructivist conditions that prevail in a classroom into which technology has been introduced (Burke, 1998).

The integration of technology into classrooms for *learners* has also revolutionised the classroom scene. Technology in a traditionalist classroom tended to be the preserve of the teacher ─ an extension of the teacher's authority, control and prestige. A traditionalist teacher might accordingly use an overhead projector to project slides or transparencies imprinted with text or images. When used in this way, technology merely confirms the hegemony of traditionalist teacher modes of instruction because the teacher remains the centre of authority and the source of instruction. But as soon as technology becomes democratised (i.e. when each individual learner has equal access to a form of technology), the teacher is no longer the sole focus of attention, the approved purveyor of information, or the guardian of pedagogic protocols. In a classroom in which technology is equally accessible to all learners, the teacher becomes a facilitator rather than an infallible authority.

The dynamics of constructivism are metaphorically visible in the actual physical *movements* that the teacher undertakes in the constructivist classroom. In such a classroom, the teacher is no longer a “talking head” who dispenses information and instruction from a privileged position (literally spatially) *above* the learner. In the constructivist classroom, the teacher is no longer even able to talk down to learners because he or she has moved (in one sense at least) onto the same level as learners: the teacher has moved *down* and *towards* the learners in order to answer their questions, observe their progress, and suggest (rather than command) possible new lines of inquiry,

activity and investigation. As the teacher moves from one learner to another in situations like this, he or she responds to calls for help, comment or guidance by responding to the uniqueness of the learners' needs. Such a teacher no longer needs to embody the dignity and prestige of the institution or the power and authority of the society that finances, maintains and sanctions the institution. The *tone* that the teacher adopts when interacting with learners is thus correspondingly different in quality from that which a traditional behaviourist teacher might adopt. The behaviourist teacher is far more likely to offer suggestions, guidelines, support and even further questions, problems and complications ─ rather than commands, solutions, definitions and *obiter dicta* (Stepich, 1996, quoted in Batane, 2004).

Dede (1998), quoted by Batane (2004, p. 390) approves of what happens when teachers use technology instead of didactic monologues. In a classroom supported by technology, teachers rotate about the room and observe learners from over their shoulders rather than from the prestigious position at the centre of the front of the room. The constructivist teacher is also far more likely to use the methods of Socratic dialogue by asking leading questions and by probing for a solution already implicit were the learner but to assemble the information that he or she already possesses. The constructivist teacher also suggests where resources might be found, but does not usually present them in a ready-made and pre-digested format. In every way, the learner in the constructivist classroom is encouraged to be responsible, to take initiative, to explore, to extend boundaries, and to discover solutions. In the behaviourist classroom, on the other hand, the learner is habituated to being a passive observer of how the teacher *works through* a problem and arrives at a situation which the learner is then invited to replicate. Reproduction, replication, centripetally, solitariness, memorisation and received dogma are all hallmarks of a behaviourist classroom. Experimentation, hypothesis, initiative, centrifugalise, trial-and-error, self-motivated inquiry, collaboration and teamwork are all hallmarks of the constructivist classroom.

As a teacher in the National Geographic Kids Network Project said:

> "I no longer spend most of my time standing in front of my class lecturing or having students reading from a textbook. I have become a facilitator, stage director, resource manager, master students, discussion leader, observer, and evaluator. For me this change has been refreshing and enlightening and long overdue. There are no longer textbooks or tests with right or wrong answers. They have become collaborators and teachers. They have become scientists, making predictions, developing hypothesis and analysing data. And they spend their money buying school pencils, folders, and banners to send home to their pen pals" (Bracey, 1994, quoted by Batane, 2004, p. 391).

Those who believe in the efficacy of technology as a means of educating children are of the opinion that *every* learner might well benefit from technology in the classroom provided that teachers use proven strategies for integrating technology into their classroom situations. While technology opens up all kinds of creative possibilities for teaching and learning, the incorrect use of technology in teaching situations will always

prove disastrous. Classroom technology needs to be carefully contextualized both in theory and in practice: it needs to be an integral part of a didactic philosophy that has been well researched and sensitively applied. No matter how promising a particular technology may be in itself, it will benefit neither teacher nor learner unless its advantages and limitations are clearly understood and taken into account in its classroom applications. The revolutionary technology such as the personal computer should be integrated in such a way into the classroom context that it will benefit each and every learner and not just a gifted (Fosnot, 1996, quoted in Batane, 2004).

The OTA Report (1995), among other research studies, confirms that teachers are of the opinion that computer technology has revolutionised their teaching methods. If each of the learners in a classroom has access to a computer for educational purposes, that classroom immediately acquires most of the characteristics of constructivist learning situation. This does not happen for educational philosophical reasons, but rather because making a computer available to each learner automatically decentralises teaching and learning in a way that is consistent with the practical principles of constructivist teaching. What happens in such a classroom, as I have noted before, is that teachers are "demoted" from their historical position as the sole repositories of knowledge.

Technologies such as computers place a corresponding onus on learners to become less passive, to take more responsibility for their learning, and become independent experts in their own right on *the means of educational delivery* (which, in this case, is the computer). It is the nature of the computer itself (rather than any kind of constructivist educational philosophy) that transforms a classroom in which computers are being used into a constructivist classroom. Since each computer is in itself an independent source of educational information, a classroom in which there are many computers is automatically one in which the locus of attention and authority becomes widely diffused rather than centralised.

The teacher does not lose dignity, authority or prestige in the computer-rich classroom. It is true that there is no place in such classrooms for teachers who cannot accept the decentralisation of activity and responsibility that accompanies the widespread use of computers for education. It is true also that modern teachers need to be experts both in their subject specialities as well as in the software programs that their learners use. "Nowadays, the teachers must be specialist in rigorous subject matter and be adept with modern technologies" (Donley & Donley, 1996, p. 6). This new "burden" on teachers simply reflects changing patterns of imparting and processing information in the larger society in which we live. The fact that modern teachers are expected to have a working knowledge of computers and widely used software hardly makes them unique. Applicants for even the most casual positions in the job market are routinely expected to be able to possess a working knowledge of computers. Most learners arrive in the classroom with far more advanced computer skills than many teachers.

It is technology itself in the form of the computer that has dealt coup de grace to traditional authoritarian modes of teaching. The role of the teacher in the computer-rich classroom is not less important; it is simply different. Whether this new role is congenial

or otherwise to the teacher depends entirely on temperament of the teacher himself or herself. Teachers who enjoy encouraging learner independence, creativity, initiative and self-actualisation will welcome the opportunities that the technological classroom provides. What is most certain is that teachers who are creative, pragmatic, imaginative and enthusiastic will find themselves very much at home in the modern technological classroom. The challenges presented by the computer-rich classroom are very great indeed, and they test the abilities of even the most gifted teachers. But the kind of teacher skills and aptitudes that ensure success in a classroom of this kind are very different from the skills, aptitudes and attitudes that maintained traditional behaviourist teaching. It is little wonder that many older teachers find it almost impossible to adapt creatively to the challenges of the computer classroom while younger teachers and recent graduates of education colleges find little to surprise them in such classrooms. This does not mean that teachers have become dispensable. They are just as necessary as ever they were. But the skills they need to make the teaching successful in the technological classroom are vastly different from the skills needed in traditional authoritarian teaching situations. The onus is on teachers to make technology-based educational a success. Without skilled choreography on the part of teachers, learners might easily lapse into old habits of futility and passivity ─ technology or no technology (Hanson-Smith, 1997, quoted in Batane, 2004).

2.4.2 Cooperative learning

One form of learning that is inimical to the traditional authoritarian classroom, but eminently suited to the technology-based classroom, is team or group learning. The presence of computers in the classroom makes it possible to divide learners into meaningful teams based on (for example) differences in ability, achievement and understanding. Teachers may, for example, use the more skilled and advanced learners in a class to coach their less advanced fellow learners. Arrangements such as this often make learning easier because learners frequently learn more easily from their fellow learners in group situations than from their teachers. In addition, learners who are entrusted with assisting their team members to master skills and solve problems are rewarded for the satisfaction that comes from having provided assistance to those in need.

Webb (1987, p. 198) notes that half a century of research and a large number of research studies have confirmed that "there is a strong agreement among researchers that cooperative methods can and usually do have positive effects on students achievement". Webb's (1987) review of the literature dealing at that time with the interaction of learners among themselves and the efficacy of group learning that focuses on computers was undertaken in order to identify:

- The pros and cons of learning in groups
- The kinds of verbal interactions that occur when small groups of learners work together at a computer
- The kinds of interactions that is beneficial or detrimental to learning
  (Webb, 1987, p. 206)

This review led Webb to the conclusion that group work is focused on computers leads to accelerated and more efficient kinds of learning. But this, according to Webb, was not the only advantage that accrued from group learning around computers. The flexibility afforded by the group learning format and by the peculiar advantages of computers also enables teachers to combine learners in groups that provide optimal learning opportunities for each team member. Hooper and Hannafin (1991), Rysavy and Sales (1991), and Simpson (1986) have reviewed the relevant literature and published articles about the value and efficacy of teamwork and cooperation in computer-assisted learning.

2.5 Teachers

2.5.1 The role of teachers

In constructivist learning, teachers, as we have already noted above, become primarily facilitators, organisers, planners, liaison officers, coordinators, and the link between learners and the resources of institution and the authorities. Teachers also become referees in the computer-assisted classrooms because the responsibility for ensuring that all the necessary conditions for learning are present ultimately resides with teachers. Yet although teachers in classrooms of this kind are "responsible" for maintaining proper working conditions and because they are "in control" in the sense of being responsible for what happens in the classroom, they do not exert the kind of centralised authoritarian control and responsibility that is the hallmark of the traditional behaviourist classroom.

The whole atmosphere in a constructivist computer-assisted classroom is more like a bazaar than the silent contemplative atmosphere that one encounters in some churches or traditional meditation rooms. The noise and bustle that is characteristic of classrooms of this kind is indicative of a specifically constructivist "working atmosphere". The "working atmosphere" of the traditional authoritarian school is, on the other hand, a deep silence in which learners brood silently, passively and alone over their books or their written problems while making as little movement is possible. The noisy bustle that the teamwork of a constructivist classroom engenders would be regarded by authoritarian teachers as an indication of the kind of chaos in which no learning can take place.

Constructivist teachers in charge of computer-assisted classrooms undertake the following kinds of activities:

- They observe the work of learners (whether single or in teams) in an unassuming, non-directed and non-invasive manner
- They intervene in learner activities only if it is absolutely necessary to give proper direction and focus to the activities in which learners are engaged
- They have a clear idea of a kind of outcomes that learners need to be able to manifest as proof of their proficiency in certain predetermined skills and activities
- They are responsible for acquiring, servicing and maintaining all forms of technology, and for arranging for the maintenance of the fabric of classroom, its furniture, equipment and accoutrements

- They encourage learners where and when necessary, and praise the achievements of groups and individuals
- There are responsible for creating and maintaining the kind of goodwill, fairness and satisfaction in a classroom without which constructivist computer-assisted learning cannot take place
- They organise and enunciate goals, deadlines, opportunities and limitations, and keep learners well-informed about what they are expected to achieve as proof of successful learning
- They assess and provide feedback where necessary on written or oral performances such as assignments, performance, portfolios and presentations
- They devise tailor-made activities and assignments for learners who find themselves out of their depth, and they themselves pay special attention to such learners or else refer them to those who can provide more systematic and remedial attention
- They ensure each learner to take responsibility to the extent that he or she is able to manage it at their specific stage of development and maturation, and they make proper arrangements for learners to engage in self-evaluation
- They encourage the development of social and personal communication skills both in groups and in individual learners
- They encourage learners to become peer instructors who will take responsibility for the welfare and competence of individual learners and of the group itself (Joubert, 2000, online).

According to Joubert (2000), the following list describes some of the roles that learners may assume in groups or teams (what the learner would be responsible for these described in brackets after the title):

- team leader or coordinator (responsible for the organisation and presentation of topics and individuals)
- recorder (responsible for the scheduling of meetings and the recording of research)
- data collector (responsible for being knowledgeable about resources; responsible also for extracting data from resources)
- media specialist or materials manager (responsible for collating data from different media)
- checker (responsible for ensuring that all members have reached their goals)
- worrier or consensus taker (responsible for ensuring on-task participation)
- encourager or supporter (responsible for ensuring that all members make fair and realistic contributions)
- clarifier (responsible for providing examples or alternatives)
- reconciler or mediator (responsible for effecting reconciliation after disagreements)
- group process monitor (responsible for observing the balance of group dynamics)

2.6 Cooperative (group) learning

2.6.1 The advantages of cooperative learning

Joubert (2000, online) identifies the following *advantages* that accrue from cooperative learning in the classroom situation:

- Learners begin to value and appreciate the interdependence that arises out of cooperative learning
- Learners strengthen their social skills and develop useful peer relationships
- Learners become more favourably disposed towards the subjects that they study
- Learners' reflective and cognition abilities develop as they are required to clarify, explain and justify their points of view to other learners or to the group
- The self-esteem of learners is strengthened, and they become more appreciative of their schools.
- The communication skills of learners improve
- Learners acquire the art of accommodating and tolerating points of view that are contrary or even the inimical to their own beliefs and conclusions
- The intrinsic motivation of learners improves.

2.6.2 The disadvantages of cooperative learning

Joubert (2000, online) identifies the following *disadvantages* that accrue from cooperative learning in the classroom situation:

- Learners who are excessively shy suffer from having to cooperate actively with other learners and make verbal presentations in the group
- More talented students tend to play down or minimise the extent their achievements and abilities so that they will not be resented or envied by the group
- Learners who suffer from low self-confidence, a lack of initiative and a fear of rejection find group work frightening and anxiety-provoking
- Because responsibilities are diffused throughout the group, some members may take it easy and rely on others to do work
- More talented group members may appropriate leadership roles at the expense of others who are less obviously talented.

2.7 Individual learning

Sinitsa (2000) defines individual learning as:

> "The capacity to build knowledge through individual reflection about external stimuli and sources, and through the personal re-elaboration of individual knowledge and experience in light of interaction with others and the environment.

This capacity is demanded practically from everyone. All learning takes place within an individual, whether within a group or not."

2.7.1 The advantages of individual learning

Sinitsa (2000, p. 19) suggests that the following *advantages* accrue from individual learning:

- Individual learning is more comfortable for introverts and shy students because it is relatively free from confrontation
- Individual learning may increase levels of self-confidence because it gives learners the opportunity to perform without outside interference
- It insulates learners from peer pressure
- It increases intrinsic motivation
- If develop self-discipline
- It provides a format in which learners can work at their own pace
- The permits learners to repeat learning tasks as often as they need to requiring mastery of the subject in hand.

2.7.2 The disadvantages of individual learning

Sinitsa (2000) asserts that the social isolation that accompanies individual learning may create negative moods such as loneliness, boredom and frustration. Because of this, he suggests that the following *disadvantages* accrue from individual learning:

- Individual learning requires a great deal of self-discipline. Not everyone possesses self-discipline to this degree
- Individual learning makes learners focus on their personal self-interest, success and achievements to the detriment of the successes, failures and difficulties of others
- The lack of stimulation from others may make individual learning boring and tedious
- Individual learning is unsupported by the possibility of immediate peer input, support, feedback and interaction
- Since no other learners are present when individual learning takes place, the learner is not exposed to social models worthy of emulation
- In the individual learning format, there is no audience for verbal presentations, summaries and explanations of what has been learned.

2.8 The role of computers in the classroom

Jaber (1997) asserts that when learners use computers to study in classrooms, there are many more ready-made opportunities (1) for exploring variant solutions to problems, (2)

for obtaining more information and insights than might have been available to the solitary learner, and (3) for collaborative problem-solving and peer stimulation. This kind of radical reorganisation of the place in which learning occurs (the classroom) inevitably creates a great deal of alienation, resistance and opposition from educationists whose experience of teaching dates from a time before the advent of computers in the classroom. In cases where more conservative teachers *are* prepared to come to terms with the new didactic format created by computer-assisted learning, they often need to undergo intensive programmes of re-education and reorientation (Jaber, 1997, quoted in Muir-Herzog, 2004, p. 113).

Computers can transform education in the classroom. Computers and their peripherals might include any of the following: hardware and software, word processing programs, graphics capabilities, programmed instruction for problem-solving, spreadsheets, databases, dial-up connections or broadband, networked connections, and other forms of telecommunication and advanced technology. From a constructivist point of view, computers differentiate intrinsically between the roles played by learners and teachers and create a format in which constructivist educational methods may be applied and realised. We may therefore say that computers transform teacher-based instruction into student-centred instruction (Forcier, 1996).

Grabe and Grabe (1996) are in agreement with the opinion that computers and the conditions that accompany their implementation create teaching and learning that is both learner-centred and more obviously amenable to group work and peer support. Because of these enormous potential advantages, the main concern in classroom instruction today is to ascertain how technology and teacher instruction may be optimally integrated. While computer tools such as word processors, spreadsheets, databases and multi-media authoring programs may assist learners to learn more actively, they also encourage learners to become responsible for their own learning. Under these circumstances, technology of the kind we have indicated here provides an obvious format for the realisation of constructivist methods in the classroom (Grabe, & Grabe, 1996, p. 13).

Maddux, Johnson and Willis (1997) state that computers play well-defined roles in schools and in society. Because of rapid technological advances in computer technology in the past two decades, it has become possible in many educational institutions to provide each learner in the classroom with his or her own computer. Because of this, computers exert a fundamentally important influence on society and on education. The computer has revolutionised education more than any other single element in education since the invention of printing. Because computers are able to function with a speed, efficiency and power that far transcends human capabilities, they challenge human beings to adapt their educational methods to suit the new conditions in which learners find themselves. Because computers so radically extend the ways in which learners can interact with one another and with the environment, one may confidently assert that "educational computing is an exciting new discipline whose effectiveness will depend on how today's teachers in training use computers in their own classrooms in the future" (Maddux, et al., 1997).

2.9 Pre-service teachers and technology

As we have noted in the section above, teachers who were educated and trained before computers became so ubiquitous in society, might well feel challenged, marginalised and alienated by the advent of technology of this kind. When teachers have already been teaching for many years without computers, the adaptation of their personal styles of interaction with learners and the notions they entertain about classroom discipline and order, often need radical revision. Teachers who have not already computer-literate and familiar with routines occasioned by computers need to be radically re-educated in the new modes of computer-assisted education delivery. This kind of re-education, especially for teachers who are nearing retirement, may provoke a great deal of resistance, anxiety, distress, negativity, and even opposition. While this is a painful experience for all concerned, it is hardly surprising. Because computer technology creates such radically new methods of classroom interaction, it needs to be sensitively and carefully introduced to those (whether teachers or learners, whether young or old) who have no previous experience of computers.

Studies support the view that it is counter-productive to attempt to integrate teachers and learners in a computer-rich classroom environment by means of sporadic courses that are intended to familiarise course-goers with the technology or the software in hand. Todd and Wetzel are of the opinion that it is far better to expose novices to a large number of courses in which the subject matter (the content) and the technology (delivery by means of computer) have already been well integrated (Todd, 1993; Wetzel, 1993). Schacter (2001) report that the most efficient way of helping teachers and learners to familiarise themselves with computer-assisted education is by providing the largest possible number of opportunities for hands-on work in courses where computers are already being used.

Harel and Papert (1991) report that the most successful kind of integration occurs as a result of continuous practical high-volume exposure to real situations in which computers are used, and not from sporadic courses that offered piecemeal and disconnected instruction. McKenzie (2001) and Scheffler and Logan (1999) note that a properly trained learner needs not only to be thoroughly conversant with all computer-related skills: he or she also needs to have acquired the essential critical skills of analysis and evaluation. It is not enough for learners simply to know how to perform certain computer tasks. He or she also needs to be able to judge the quality of what is performed on and achieved by means of the computer.

In-depth computer-assisted education is therefore essential for pre-service teachers. These teachers need to have become so skilled in computer-related tasks and procedures, and so comfortable in an environment in which education is being delivered by means of computers, but they are able to pass their knowledge on to learners with maximum self-confidence, skill and efficiency. It goes without saying that the student teachers who arrive at college with a good deal of prior computer experience will find it far easier to learn what they need to know about using computers for educating learners within the classroom (Laffey et al., 1998; Hochman, Maurer, & Roebuck, 1993; Kearns, 1992). Dr

Lynda Roberts, a special adviser on technology to the United States Department of Education, wrote: "If you can get teachers to use technology effectively in their own lives, you have won 90 percent of the battle" (Rosenthal, 1999). Rosenthal describes how the National Council for Accreditation of Teacher Education (NACTE) requires all colleges and universities thoroughly to train pre-service teachers in the skills required for computer-assisted education in classrooms. He notes that this cannot be achieved merely by discrete and random "short courses" in technology. Student teachers can only be properly trained with the skills of this kind if they are trained in the context of a major programme that is didactically sound and based on sound research and content, and that extends from the first to the last year of student teacher training.

Brush (1998) concurs with this opinion as he calls for integrated technology training throughout the teacher education programme. Computing instruction integrated *throughout* the teacher education program is, according to Moursund and Bielefeldt (1999), far superior to isolated and sporadic computer classes that are not part of a larger curriculum design. Student teachers who have received the kind of integrated computer instruction that we have described here should have skills far in advance of teachers who have been trained by means of in-service courses.

Wang (2000) believes that pre-service teachers who are placed in practical settings with teachers who view the efforts to integrate technology into the classroom as an unnecessary nuisance and hindrance to routine work, will never learn properly to appreciate the value and potential of computers in education. While a great deal of research has been undertaken on the topic of how pre-service teachers perceive and understand technology, Diegnueller (1992) points out that "some perceptions of good teaching practices may reflect an obsolete educational system" (Diegnueller, 1992, p. 512).

As part of their research into the perceptions of pre-service teachers on how the roles of teacher have been changed by technology, Carr-Chellman and Dyer (2000) asked pre-service teachers to respond to a reading about the future vision of education. The results showed that many respondents preferred traditional teacher roles that reflected the kind of teaching methods that they had experienced as learners. The researchers suggest that these responses are very much in line with the way in which human beings respond to change in general. Because teachers would prefer teacher roles to conform to what they personally experienced as learners and as students, they tend to be less than enthusiastic about any radical deviations from their expectations. Carr-Chellman and Dyer's (2000) results therefore probably reflect more accurately how teachers view the changes that are taking place in the education profession in general rather than how they view the role of technology per se in education.

Technology is also changing the way in which schools, colleges, universities and departments of education prepare teachers and measure their success, both in measurements used and in actual performance. Many teacher preparation programmes currently require that pre-service teachers are able to present well-prepared programmed lessons in their methodology and content courses. They have to give suitable evidence

that they have conducted online research projects and that they have considered projects that are linked with learners in elementary or secondary classrooms and students in universities. They also need to be able to demonstrate their ability to integrate technology in appropriate ways into their lesson plans.

Hardy (1998), McNamara and Pedigo (1995), Siegel (1995), and Walters (1992) indicate that teachers must be able to use computers competently and efficiently in their classrooms, both as vehicles of pedagogically-sound instruction and for purposes of classroom management. They must also possess a working knowledge of hardware and various software applications. Siegel (1995), Schrum (1999), and Strudler and Wetzel (1999) agree that even if teachers are basically positive in their attitude toward the use of technology for educational purposes, they are unlikely to feel comfortable or competent about using technology in their classrooms if they are not given adequate support in the form of time, training, access and backup services.

Poole and Moran (1998) suggest that deficiencies in staff development prevent teachers from utilizing existing technology in their teaching. They expand on this by asserting that "one-shot workshops, added expense of training, lack of continued support, isolated knowledge, unawareness of school needs, lack of knowledge and support from leadership all contribute to the ineffectiveness of technology staff development". They feel that it is the *teacher* who is best able to judge when the time, situation and place are right for integrating technology creatively into the learning process. It also teachers on the job should this be able to judge what kinds of technology are suitable for their teaching programmes. The Michigan State Technology Plan has identified the kind of advances that have been affected by the transformation of education through technology. A technology that is appropriate and well-suited to specific educational purposes should allow:

- Student-centred learning
- Mass-customisation with accompanying instructions as to how individual student needs may be met
- Flexible pacing based on student abilities
- Distributed learning from any place and at any time
- Critical thinking in real-world contexts
- Collaboration and dialogue among students, and between students and teachers
- Standards, strategies and statistics
- Up-to-date primary information resources and parent-teacher communication on a daily basis (The Michigan State Technology Plan, 2000).

These advances are in sharp contrast to the more traditional, non-technology-supported kind of education that emphasizes learning that is tied to a teacher, classroom and school building during school hours, that utilises textbooks that our often sadly out-of-date, and that schedules only one parent-teacher conference per semester.

Batane (2004) describes how teachers in Botswana are faced with daily challenges because of the far-reaching changes are taking place in schools and in society. One such change has been introduction of computers into schools. It is on the shoulders of teachers that the burden of understanding, maintaining and making proper use of these computers in the classroom falls. Research, however, indicates that the teachers themselves need in-depth training in the use of computers and in techniques of integrating computers with classroom education. It is absurd to expect teachers to function in computer-endowed classrooms without proper training, guidance and orientation. In-service training, furthermore, is arranged and applied differently in each school. The main challenge is how to improve the quality of education by the successful integration of computers into classrooms (Stepich, 1996). If this is to happen, appropriate computer courses need to become an extensive part of the syllabus of student teachers, and in-service teachers need to be given more than the sometimes perfunctory training that they now receive. Whether teachers feel comfortable with computer-assisted teaching or not, teaching of this kind is obviously here to stay, and teachers need to do everything in their power to make themselves as proficient as possible in computer skills and in computer-assisted teaching techniques (Barnett, 2000, quoted in Batane, 2004).

Alden (2000) asserts that the most effective teacher training programmes are those that allow teachers first to learn how they themselves can benefit from technology. Teachers need to be shown the extent to which computers can make their lives easier, more productive, or pleasurable and more satisfying. There are computer programs that teachers can use to plan and develop lessons, to create learning materials, to perform tedious calculations, to create and distribute messages and information, and to prepare notices, letters and other documents (Batane, 2004, p. 389).

2.9.1 Technological preparedness on the part of teachers

A number of research studies describe how ill-prepared teachers are to use technology for instructional purposes in the classroom (Beaver, 1990; Brooks & Kopp 1989; Roblyer 1994). The results of the survey of 1100 student teachers indicated that more than 90% of them needed a great deal more hands-on training before they might be regarded as sufficiently knowledgeable and prepared to use computers for the own purposes and to teach computer-assisted education (Berger, Carlson & Novak, 1989). Another survey conducted by Hurteau (1990) in New York State revealed that only 20% of respondents felt that they had been given an adequate amount of training in the use of computers for instructional purposes.

The attitudes of elementary school teachers towards the use of computers in classrooms are bound to have crucial effect on the preparedness of their learners in primary and in high schools. This in turn will affect the computer skills of successive generations of school leavers and consequently of the workforce itself. By now it is well established that it is only teachers who are proficient and comfortable with technology who are able to assist their learners to use technology successfully and efficiently. In a survey conducted in colleges, schools and departments of education in the United States to determine how well teachers had been trained to use computers and teach its uses to others, the Milliken

Exchange and the ISTE found that there was very little difference between the teachers' levels of skill and those of their learners (Moursund & Bielefeldt, 1999, p. 28). The survey also concluded that the best way to improve teacher computer skills would be by more intensive exposure of student teachers to technological education and management throughout their years of vocational preparation (Moursund & Bielefeldt, 1999, p. 10).

2.9.2 The role of technology in pre-service education

The purpose of Batane's (2004) Botswana research into in-service training and technology integration into the teaching and learning process was to determine how well disposed the teachers of a particular high school in Botswana would be towards working with computers in their classrooms. The findings predictably showed that those teachers who had the best computer skills in the school were the teachers of technology, while teachers who had no professional technological training were dissatisfied with the kind of computer training that they had received. Unfortunately even those teachers with inadequate computer skills were expected to train learners in the whole range of computer skills that they needed to continue their studies and seek employment in the job market.

Eby (1997) has remarked that technological skills are a sine qua non of modern teaching, and that the instructional programs now being used in most schools cannot function without adequately trained teacher instructors. Teachers therefore need to be properly trained in technological management if the programs themselves are to function adequately. Inevitably, teachers who rated themselves as improperly trained lacked the confidence they needed to train learners. This lack of confidence also presumably affected their self-image and self-esteem adversely. As is often this case with teachers, they had been thrown in at the deep end without being taught how to swim. It is perhaps a reflection on the training they were given that even after being trained, a number of teachers still felt unable to meet the demands of computer-assisted education (Batane, 2004).

As each year passes, technology is being used more and more intensively in every sector of society. In spite of this exponential increase in technology-related activities and skills in all walks of life, elementary school teachers are still not being properly trained to integrate technology with the teaching, and elementary school teachers themselves are not being given the opportunity to keep abreast of the latest developments in computer-assisted education and accompanying forms of software. Even as more and more money is being made available by governments and corporations for the funding of computers in educational settings, there are misgivings about the quality and extent of the programmes that have been put in place to train student teachers to handle computers efficiently. Gerald & Williams (1998) have indicated that K-12 schools will employ about two million new teachers by the year 2008. Because we live in a society in which computer technology is now well integrated into most aspects of life, there is a corresponding burden on universities and colleges of education properly to train these teachers before they leave universities and begin their careers. Student teachers need to be given as many

opportunities as possible to observe how technology is already being used effectively in their universities and colleges. They need to be exposed to these programmes and given opportunities to obtain first-hand experience of how computers are already effectively integrated in innumerable teaching situations (Hill & Somers 1996).

In spite of these clearly understood needs, the Office of Technology Assessment (OTA, 1995) has reported that most graduates arriving in the teaching profession possess but an imperfect knowledge of how to incorporate technology into their classroom practice ─ even though they could manipulate and navigate their way around a limited number of widely used programs. Only one in ten, however, possessed the skills to cope with more advanced forms of software and undertake fairly routine classroom tasks such as electronic presentations, and few were able to devise lesson outlines and support material for the teaching of technological skills in classrooms. The OTA study also reported that "overall teacher education programs in the United States do not prepare graduates to use technology as a teaching tool"
Online Available
http://0-ww.wws.princeton.edu.innopac.up.ac.za/ota/disk1/1995/9541.html

And while a study undertaken by the National Centre for Education Statistics (NCES) (2000) and that reform of education cannot take place without the incorporation and integration of technology into educational structures, only 20% of teachers possessed the necessary skills to make technology central to their teaching. Trotter (1999) reports on a study carried out by the International Society for Technology in Education (ISTE) in which 416 colleges of education were surveyed. The results of this study show that the student teachers in these colleges were not being adequately prepared to maximise the potential benefits of technology in the classroom and to pass on their skills and expertise to their future learners. Another important study by the NCES (2000) reached the following conclusions:

- Only 50% of the teachers surveyed who had computers (and Internet connection) in their classrooms actually *used* these computers for purposes of instructing learners
- Of these, 61% revealed that the most advanced usage to which they put the computers involved word-processing and spreadsheet operations
- Only 33% of all respondents were of the opinion that they possessed sufficiently adequate skills to benefit from the computers and the Internet connection in their classrooms
- Another 33% of the respondents believed that they were sufficiently skilled to obtain real benefits from their computers and from their Internet connections
- 93% of the 33% (referred to in the immediately previous item) revealed that they acquired their skills by themselves ─ and not from colleges, in-service training courses, or any other official source.

These findings about in-service teachers, and others like it, suggest that it is vitally important for colleges of education and other teacher education institutions to devote far more time, energy and funds to the technological education of their student teachers (and, indeed, to the further education and training of in-service teachers).

The study conducted by Wentz and Wentz (1995, p. 49) concludes that the inclusion of technology in elementary school classrooms would compel elementary school teachers to use the technology to teach the syllabus. There is no point in spending vast amounts of money on expensive technology that is never used, and education administrators should be the first to appreciate this. The only reasonable way to compel teachers to use the technology at their disposal would be to design curricula and lesson plans in such a way that the teacher concerned would have to use the technology to teach the content. While the design of the curriculum may compel teachers to use technology, teachers cannot be blamed for using it ineffectually and incorrectly if they have never been exposed to practical hands-on work with technology over a long period of time. It is all very well to say that they should be an onus on the teacher to train him or herself in the use of classroom technologies at his or her own expense. The kind of technology that we are thinking about here is extremely expensive. In addition to this, much of the software that is used is anything but straightforward ─ especially for those who have had minimal or zero exposure to computers outside the classroom and outside their normal line of duty. Self-coaching and self-training are indeed efficacious (especially when it comes to practising routines and manipulating software with which one is already partly familiar). But teachers ─ especially elementary school teachers ─ are notoriously badly paid, and once they begin teaching, they have very little disposable free time (except during school holidays). It may sound reasonable to expect teachers to train themselves. But if this is to happen, then teachers need to be given incentives in the form of equipment, grants and time (leave), not to mention support and backup systems. This is a problem that admits of no easy solution, either in developed countries or in Africa where deficits in skills, time and money continue to be crucial components in the equations of deprivation.

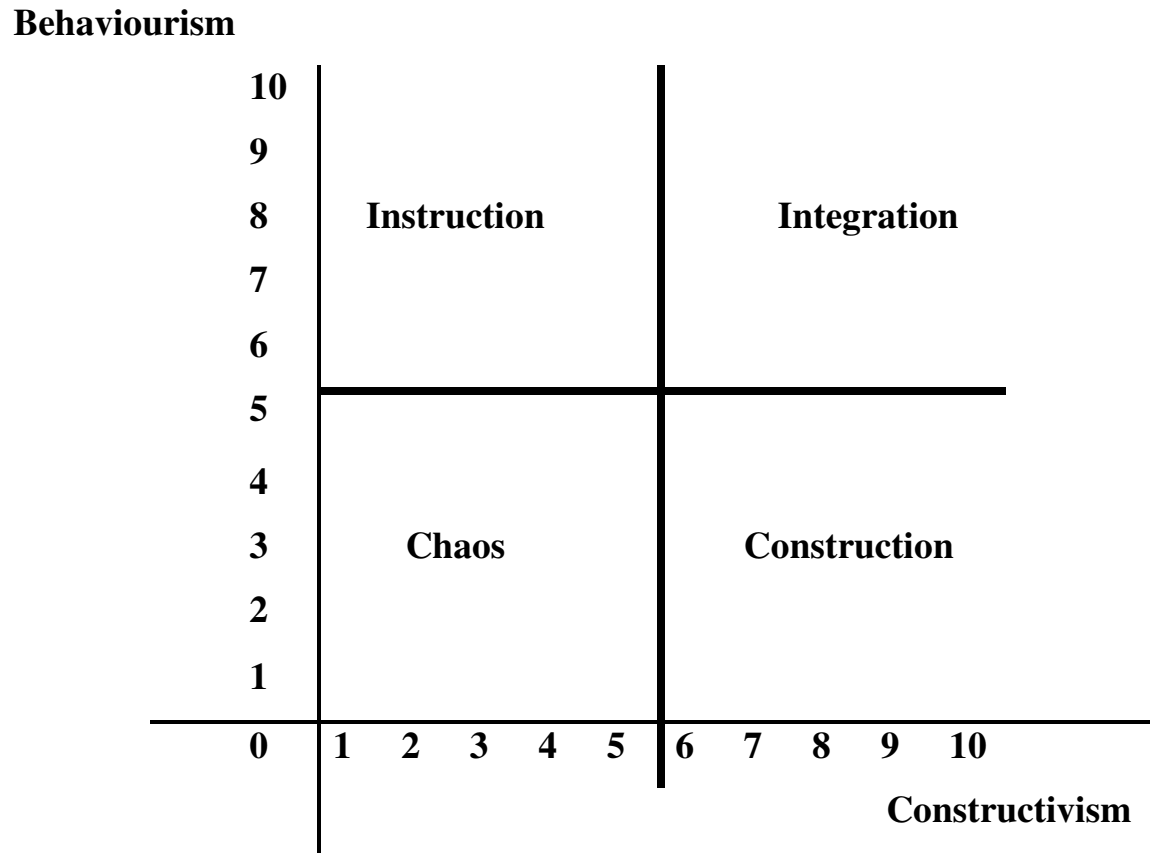
These problems should also be considered in the context of other difficulties that complicate the picture. It is generally agreed by all researchers that colleges of education need to provide the training and skills that future teachers will need (Handler & Strudler, 1997; Thomas, 1999; Wang & Holthaus, 1999). The difficulty, however, is that there is seldom an integration between the computer skills that are being acquired and integration of computer technology in classroom teaching. There is obviously little point in having one without the other. The skills and training that a student teacher receives are ends in themselves. They are designed prepare the teacher to use technological skills in classroom. When student teachers are tested for competence in technological skills and in teaching method, they should be able to give convincing demonstrations of how they can use technology in a classroom to deliver subject content. Wang & Holthaus (1999) have observed that most student teachers are unable to integrate technology effectively with their teaching in classrooms, and that computer training that they have received only allows them to use computers for purely personal (i.e. non-teaching) purposes. This seems to indicate what other research has already proved: that although student teachers are being trained to use computers, they are not being adequately train to teach learners in

classrooms in which each learner has access to a computer. This then is the next major problem that faces those who are responsible for making future teachers competent practitioners of computer-assisted education.

2.10 The theoretical framework of a constructivist theory of learning

The theoretical framework for this study is based on Bruner's (1996) description of constructivism. About this kind of constructivism Bruner writes: "Learning is an active process in which students constructs new ideas or concepts based upon their current or past knowledge. The students select and transform information, construct hypotheses, make decisions, [while] relying on their cognitive structure" (Bruner, 1966). In this study, I have made use of an objectivist approach to analyse the data. This objectivist approach is, according to Cronje (2000), the complementary opposite to the constructivist approach that Cronje describes in his two-dimensional, four-sector model (Cronje, 2000). According to Cronje (2000), objectivism/behaviourism and constructivism are diametrically opposed to one another in methods, means, assumptions and purposes (as the model clearly shows). When the two approaches are kept at right angles, behaviourism and constructivism they produce four conditions of learning. Cronje's four quadrants are labelled Instruction, Integration, Chaos, and Construction respectively. Figure 2.1 (below) shows the four quadrants more clearly.

Figure 2.1: The Four Quadrants of Cronje's Model (2000)



The figure above shows how objectivism (behaviourism) is the complementary opposite of constructivism in Cronje's (2000) model that portrays the four possible quadrants of teaching and learning.

Cronje (2000) states that among the possible theoretical opposites portrayed by the model, objectivism/behaviourism and constructivism form one set of polar opposites. While the behaviourist approach assumes the presence of an existing reality *outside* learners, and consequently advocates behaviourist techniques such as conditioning as an appropriate method for training and educating learners, the constructivist approach, on the other hand, suggests that there is *no* objective reality exterior to learners, but that all learners (and all human beings) construct their own meanings, and that these meanings are their "ultimate reality". Although these two approaches are fundamentally different, they reside on the polar opposites of a continuum of the same model, and a researcher may, depending on the desired outcome, select and utilise techniques from opposite or adjacent quadrants in the pursuit of his or her research. In order to actualise a particular outcome in teaching and learning from the four quadrants, interaction is required. Each of

the four quadrants depicted in the model is valid in itself, and each describes modalities of teaching and learning that have appropriate places in education.

2.10.1 The complementarity of objectivism and constructivism

The differences in teaching and learning in the four quadrants of the model are as follows:

Chaos
In this quadrant learning is opportunistic; this means that learning is low in objectivist and constructivist elements. While no proper learning should, in theory, take place in this quadrant, most learning seems to take place in this way. The learning environment does not need to be supportive for learning to occur. The kind of learning depicted in this quadrant is therefore referred to as "incidental learning".

Instruction
This is the quadrant where we would situate programmed learning which makes use of tutorials, lectures, and drill-and-practice. It is high in intuitivist elements. This quadrant supports the *behaviourist* process of learning.

Construction
This quadrant reflects the constructivist paradigms of teaching and learning. The outcome of the "construction" is subjective and individual understanding and knowledge (the opposite of the "objective" knowledge posited by behaviourism).

Integration
In terms of this model, "integration" means combining instruction and construction in appropriate ways for the purposes of education. The kind of learning depicted in this quadrant requires a prior elucidation of goals and outcomes. The instructional designer would be categorised in this domain. The educationist selects appropriate behavioural instructions and constructivist learning events to achieve desired outcomes.

2.11 Teaching and learning theories

Bruner states that learning comprises "an active process in which students constructs new ideas or concepts based upon their current or past knowledge" (Bruner, 1966). Between the bare definition of constructivism and constructivist research, it is necessary to select the kind of research design and activities that conform to the definition of constructivism outlined above. For the purposes of my study, I have designed activities (authentic tasks) on which I required students to work either singly or in groups

Because I was using a constructive approach, the subject matter with which the students in the sample were required to engage only became personally meaningful, and therefore comprehensible, to them in the context in which they were working. While constructivist learning theory accommodates group learning, it is only in each individual student's mind

that the authentic tasks with which they engage become meaningful. Each individual student, in other words, is personally responsible for the way in which he or she approaches and analyses the tasks, and assesses the competence of his or her performance while he or she is doing so.

In addition, the role of the teacher or instructor in a constructivist classroom is, as we have already noted, drastically different from that of the behaviourist teacher. Gergen (1995) regards teachers as coordinators, facilitators, resource advisors, tutors or coaches. Such designations are obviously at odds with definitions of the teacher as "the prime actor" or "the sage on the stage". This understanding of teaching also subverts the behaviourist characterisation of teaching as the transmission of knowledge from the enlightened (teacher) to the unenlightened (learner) in the process of education. Constructivism reinvents teaching is a process of facilitating student learning, with "the student as the prime actor and teachers as guides on the side or behind" (Brooks & Brooks, 1993). Knowledge, in a constructivist view, is not "out there" to be received or instilled. It is ultimately always "in here", i.e. in the mind of the learner, and it needs to be constantly created and recreated by each individual (learner) for himself or herself. Bruner states that "learning is an active process in which students constructs new ideas or concepts based upon their current or past knowledge. The students select and transform information, construct hypothesis, makes decisions, relying on their cognitive structure" (Bruner, 1966).

I have also used elements of Skinner's theory of behaviourism, as cited in White (1995), in this study to guide my research and practice. As we noted above, behaviourism declares that human behaviour may be characterised as a response to experiences that people have undergone in the past. Skinner also posited the concept of operant conditioning, which is a person's response to behaviour that has been reinforced by positive stimulation (White, 1990).

The study also includes an important pedagogical dimension. According to Lovat (2003, p. 11), effective teachers "have a rich understanding of the subjects they teach and appreciate how knowledge in their subject is created, organised, linked to other disciplines and applied to real-world settings or authentic tasks". Lovat goes on to say that:

> "a good pedagogy requires a broad repertoire of strategies and sustained attention to what produces student learning in a specific content domain, with a given group of students and with a particular teacher. Teachers need to rely on quality educational research for different pedagogical models and strategies; at the same time they have to practice the art and science of teaching themselves, refining it as they go according to their own needs and resources and particularly those of their students" (Lovat, 2003).

I have deliberately designed this study to include a pedagogical dimension, and was guided in the construction of this pedagogical component by constructivist theory and assumptions. I accordingly prepared a learning event that is both constructivist and

authentic for the pre-service teachers from the ISCED sample. Before they engaged with the learning event, I presented a brief overview of the constructivist pedagogical framework, and explained to them that they would be expected to use constructivist methods as pedagogical strategies in their future teaching practice as they integrated ICT into classroom practice.

According to Lipponen, (1990, p. 368) pedagogical practice in a constructivist learning situation needs to be meaningfully integrated into the culture and environment of those who are engaging in learning and teaching. That means that if technology is used, there is a need to "build social structures that encourage learning for supporting reflective discourse and for helping students build knowledge and deepen their understanding of their subject domain" (Lipponen, 1990). The main aim of this study is to enhance authentic task-related activities that will encourage the cognitive application of related information in society.

2.12 Technological implications for this study

The technology that is central to this study comprises information communication technology (ICT) and its correlatives in terms of equipment, technical support, collegial support, and classroom implementation (Lipponen, 1990, p. 369).

2.13 Organisational implications for this study

What concerns me here is what one needs to do to mobilise the support of the whole school for education that incorporates ICT (Lipponen, 1990, p. 370). However, in this study and in a constructivist context, organisational aspects are referred to as the logical organisational contents of knowledge that is being used by the pre-service teachers who study Computers in Education course.

2.13 Summary

In the midst of many discouragements, it is important to remember that the opportunities presented by the new millennium are unprecedented in the history of education. For the first time in history, technological advancement offers us forms of technology which, if properly integrated, are able to support and empower teaching and learning in a way that was unthinkable even a few decades ago. Research from the literature suggests that our society will continue to rely more and more on technology in an increasing number of ways, and that this is a cumulative process that is unlikely to be reversed or impeded except possibly by circumstances that are unimaginable to us now. Because the lineaments in the future have become so much clearer with regard to technology, there is an obligation on contemporary educationalists to exert themselves to design and devise ways and means of integrating these advanced forms of technology into teaching that was previously unsupported by forms of technology such as are available to us now. As educationalists, we owe it to the future to ensure that our countries will not be left behind as the next wave of technological modernism sweeps over the educational landscape.

It is my opinion that the kind of material, moral and financial support that government and the private sector currently offer to primary schools, colleges and universities, will not only continue, but will continue to expand, as opportunities and resources permit. Learners need to be offered the technological skills and expertise that will enable them to excel in their private lives and in their work. Nowhere is this responsibility greater than in the sphere of education because today's learners will be tomorrow's citizens and leaders. Current literature provides us with clear information about how traditional teaching models have been subverted and revolutionised by the introduction of computers and other forms of technology into the classroom and the home. Because such changes affect the well-being and future of every citizen on this planet, we as educationalists need to take these new forms of technology into account as we plan our school systems.

The literature also agrees that the integration of technology into curricula, colleges and universities has created enormous challenges for those who are engaged in the education and preparation of future teachers. These new teachers need to be comfortable and competent in handling new technology because they are the ones on whom the responsibility for integrating technology with teaching will fall. In this chapter I have also made it clear that the responsibility for equipping teachers with vital technological skills should begin at universities and in teacher training colleges because we cannot (for reasons that I have outlined) expect individual teachers to make themselves competent in technological skills by relying completely on their own unaided resources (although that is what frequently happens). There are many reasons why certain teachers are simply unable to educate themselves in computer technology, and this might well constitute a useful topic of study in itself. In developing countries in Africa especially, many people simply do not have the resources to train themselves in technological matters.

The literature indicates that those responsible for making critical decisions about the implementation and use of technology in classrooms often make those decisions without proper information or an adequate understanding of contextual factors and relevant background. The United States Department of Education (1998) pointed out that decisions of this kind must take into account all affected stakeholders, and these include teachers, students, parents, administrators, and members of the community. An adequate understanding of the current status of technology used in the school system constitutes the first step in making decisions of such far-ranging importance for any particular national education system.

CHAPTER 3

Research design

3.1 Introduction

This chapter provides a detailed explanation of the methods that the researcher used to investigate the way in which pre-service teachers were able to integrate computers with instruction in a constructivist learning event in the Faculty of Education at ISCED in Lubango, Angola. As teaching on the basis of constructivist principles is becoming more and more widespread, it is having a profoundly transformative effect on the teaching and learning processes in many schools (Marzano, 1992; McClelland, Marsh, & Podemski, 1994). The most important premises of constructivism in education are the following:

- Learners construct their own meaning by means of personal engagement with problems and activities in authentic learning tasks.
- Learners are dependent on their existing understanding when they take part in new learning activities (all existing understanding and knowledge are primary resources in the learning process).
- Social interaction is fundamentally important in the learning process.
- Authentic learning tasks are a necessary precondition for meaningful learning (Bruning, Schraw, & Ronning, 1995; Pressley, Harris, & Marks, 1992 as quoted by Applefield, Huber, & Moallem, 2001, p. 38).

The study made use of a constructivist learning event which was administered to pre-service teachers at ISCED. The constructivist learning event was the primary means for investigating the extent to which pre-service teachers were able to integrate the use of computers in a constructivist learning format. The following sections explain the methodology and design of the study.

3.2 The case study at ISCED in Lubango

I selected the *case study* in the design stage because the case study seemed best suited for obtaining the kind of insights that I was hoping to gain from the research. In the event, the case study enabled me to understand the viewpoint of the select sample of pre-service teachers at ISCED who were being prepared to use computers for their future teaching and learning processes in schools. ISCED, the only teacher training college in Huila Province, is situated in the city of Lubango. The college uses computers for teaching the Computers for Education course.

Yin (1984, p. 23) defines a case study research method as an "empirical inquiry that investigates an existing phenomenon within its real-life context, when boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used". An alternative definition is provided by Merriam (1988). He defines a case study as "an examination of a specific phenomenon such as a program, an event, a person, a process, an institution, or social group" (Merriam, 1988, p. 9). The study focused on the Computers for Education course offered by ISCED. ISCED is an exceptional case as it is the only institution in Angola offering this type of the course for the pre-service teachers.

3.3 Description of the research

This study follows a qualitative approach because it permitted the researcher to share the attitudes, understanding and thought processes of the pre-service teachers as they worked on the particular constructivist learning event which had been designed for the. The case study seeks to understand the extent to which pre-service teachers are being prepared to integrate computers in their future teaching activities as professional teachers.

3.3.1 Sampling process

The sampling process of the case study was purposeful because ISCED is the only institution that has a computer laboratory and that offers the course such as the Computers for Education course. The purpose of the constructivist learning event (as may be seen from Appendix 3.4) is to create a situation in which the sample of pre-service

teachers at ISCED demonstrate the extent to which they are able to use computers as an adjunct to classroom instruction. Although 21 pre-service teachers volunteered to participate in the study, 30 students were ultimately selected to constitute the sample.

3.3.2 Description of methodology and procedures

The intervention or learning event was designed in such a way that the pre-service teachers who took part in it would be able to demonstrate the extent to which they had been prepared up to that point to use computers as a means of instruction in classrooms. Because constructivist theory informed the design and development of the learning event, the learning event reflected a constructivist approach to teaching and learning. The constructivist theory of learning was used because it enabled the researcher to observe and identify the existing experience and knowledge of learners as they used computers in the teaching and learning process. This constructivist learning event allowed the pre-service teachers to construct their own learning as they worked on the task. It also gave them opportunities to demonstrate their social skills and teamwork skills in the context of an authentic task that had been deliberately designed to allow them to learn in a meaningful way (Applefield, Huber, & Moallem, 2001; Dils, 2004). The following discussion describes the constructivist learning event that was used in the study.

3.3.2.1 The constructivist learning event

The major constructivist premise in education is that learners learn by *doing*, i.e. by performing meaningful activities on the basis of previously acquired knowledge and understanding (Balli, & Diggs, 1996). The pre-service teachers in the sample were therefore required to complete the constructivist learning event by: (1) using their existing computer knowledge to search for information on the Internet, (2) creating documents in Microsoft Word and recording their results in these documents, and (2) presenting their results in a Microsoft PowerPoint format. All these elements were built into the constructivist learning event designed by the researcher.

The learning event was prepared by the researcher and presented to the pre-service teachers at the beginning of the research study (see Appendix 3.4 for the physical

presentation of the learning event). The pre-service teachers were expected to apply their previous computer skills and whatever they knew about malaria in Lubango, Angola, in the learning event. Because malaria is a serious and frequently fatal endemic disease in this part of Angola, it was assumed that most of the pre-service teachers would be reasonably well-informed about the disease.

3.3.2.2 The constructivist learning event – a description

The aim of the study was to use a constructivist learning event that would allow the pre-service teachers in the sample to demonstrate that they were able to integrate computers in their learning process and thus to supersede the traditional model whereby teachers are the sole providers, directors, arbiters and focus of knowledge and learning processes. According to Hein (1991), learners can "construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences". My presuppositions in constructing the study were that if the purposively selected sample of pre-service teachers from ISCED were given an opportunity to do an authentic task, they should be able to complete an authentic learning task by integrating their previous knowledge of malaria with their existing computer skills ─ and thus give me as a researcher demonstrable evidence of the extent to which the course Computers in Education at ISCED might be said to be efficacious. Cobb (1994) believes that learning is a constructive process where students, who are the pre-service teachers, do not need to be passive, to only sit and receive information, but instead allow them to be active, so that they construct knowledge as they strive to make sense of their worlds or surroundings.

Design of the learning event – The constructivist learning event was designed by the researcher. The learning event was prefaced by a short introduction that described malaria in Lubango, Angola. Firstly, the pre-service teachers were then required to supplement this information by obtaining further information about malaria from the Internet and from books in the library. Secondly, they were required to obtain first-hand information about the impact of malaria on people in and around Lubango from the local hospital. Questions that had to be answered included: How many people on average die from malaria each week, each month and each year? Which population group is most

affected? Are adults or children more susceptible? Are males or females more susceptible to contracting malaria? Are teenagers and pregnant women more likely to contract malaria? The pre-service teachers would therefore have access to real-life data as they worked on the authentic problem of understanding and assessing the role that malaria played in the life of the people of Lubango. Thirdly, they were required to collate and compile the information and data by using Microsoft Word, Microsoft Excel and Microsoft PowerPoint on the computers they had at ISCED. Finally, they had to present their findings to the class, and encourage discussion on what they had presented. In addition, the pre-service teachers had to save all their activities to floppy disks.

Because the learning event was constructivist by design, it also required the pre-service teachers to work in groups (four students were allocated to each group). The group work was an important part of the study because it gave the students opportunities to use and demonstrate the social skills that are a necessary part of any authentic learning process in terms of the constructivist paradigm of teaching and learning. Social learning allows learners to engage in active dialogue as they work together to construct knowledge. The Southwest Educational Development Laboratory (SEDL, 1995) believes that learning does not end when teachers provide information, but that "people learn by doing, by interacting with others and especially through authentic (real-world) tasks and sharing of experiences" (SEDL, 1995).

The development of the learning event – The researcher developed the constructivist learning event by using Microsoft Word software. Appropriate instructions and assessment processes were all included in the task itself. I prepared only one task for this study because of time constraints. Pre-service teachers were allocated to work in groups, and open discussions were held during the preparation and presentation sessions. All the pre-service teachers involved in the research were required to participate where appropriate.

The implementation of the learning event – The constructivist learning event was introduced into the classroom on the second day of the research study. All twenty-one

pre-service teachers who had volunteered to participate in the research study were given the brief to read in hard copy format. This printed version was given to them so that they could refer to the instructions as they sat in groups. They prepared questionnaires and other interview questions to facilitate data collection before they went out to the hospitals to do the research required.

Students in all groups managed to conduct searches for information on the Internet by using ISCED computers and the Internet connection provided in the laboratory. They found up-to-date information on the Internet about the effects of malaria in Angola and in other countries, and they included this information in their reports and presentations. More importantly, they also located a selection of pictures of the life cycle of the malaria parasite as well as graphics that showed how the parasite moves from one person to another as part of its life cycle. This seemed to me to be a promising beginning because it showed how the pre-service teachers in the sample were able to use their previous understanding and knowledge about malaria to search for the right kind of information and how they were able to support their presentations with appropriate graphics, diagrams and tables.

Social learning skills were evident among all the pre-service teachers who took part in the study. They all worked collaboratively in groups and engaged enthusiastically in productive dialogue. There was also no evidence of animosity, disruption or aggressive competition among the participants. The students worked well in teams because all the members of the groups participated to a more or less equal extent.

The pre-service teachers worked on their constructivist learning event for almost eight hours. Each group prepared a thirty-minute PowerPoint presentation. After every presentation there was a discussion session. The PowerPoint presentations were very successful and effective as the computer laboratory at ISCED had a data projector that allowed learners to showcase their computer, presentational and discussion (social learning) skills. Some of the groups used animation, colours, pictures, tables and impressive, eye-catching backgrounds.

The negative side of the study was the time constraint within which the pre-service teachers were obliged to complete their research and presentations. My own opinion as the researcher and designer of this study is that if there had been enough time, the pre-service teachers could have designed their own constructivist lessons by using any suitable topic of their choice, and that they could have presented these original productions to their peers for comment. If the constraints of the research process had allowed me to give the pre-service teachers an opportunity to design their own constructivist learning events, I am convinced that their productions would have demonstrated even more clearly how students of this kind are able to use a constructivist paradigm to integrate computers into the teaching and learning processes both in schools and in the real world.

Evaluation of the learning event – I evaluated the constructivist learning performed at ISCED by using two main instruments: an observation checklist and rubrics. I used the observation checklist to observe and record the social skills used by the pre-service teachers as they worked on the constructivist learning event and during their PowerPoint presentations. The observation checklist was divided into three sections under the headings *pedagogical*, *technical* and *organisational*. The rubrics used a three-scale assessment method that offered the following three degrees: 1 ─ Poor; 2 ─ Good; 3 ─ Very Good. I used this rubric to evaluate all the saved documents on the computers that were prepared by the pre-service teachers. The first part of the analysis process of the results was based on Cronjé's Model of the Four Quadrants (2000), which plots objectivism as complementary to constructivism. This was discussed in depth in chapter 2.

I performed the second part of the analysis of the results by using an interpretive process of analysis in which themes and issues relevant to the constructivist learning process were selected according to pedagogical, technological, and organisational criteria. The following section describes the data collection instruments that were used in the study.

3.3.3 Data collection instruments

Several research instruments were used for data collection in this study. They included questionnaires, interviews, an observation checklist, and rubrics.

3.3.3.1 Questionnaires

Semi-structured questions were used for the purposes of the study. The questionnaire had three sections which were divided into three areas of inquiry. The areas of inquiry were: (a) pedagogical (b) technical (c) organisational. Each section contained three questions (and so the questionnaire contained a total of nine questions altogether). The questionnaires were administered to all the pre-service students and to the two ICT teachers at ISCED. (The questionnaire is contained in Appendix 3.1.)

Questionnaire for the pre-service teachers

Twenty-one pre-service teachers completed the questionnaire at ISCED on the second day of the study before the constructivist learning event began. The questions in the questionnaire were intended to provide the researcher with a view of what pre-service teachers' understood by the use of computers in classroom situations, as well as how they understood the pedagogical, technical and organisational processes that had been used to prepare them for using computers in future classroom situations. All these questionnaires were then collected and analysed.

Questionnaire for the ICT teachers

Because the two ICT teachers who were teaching the pre-service teachers at ISCED were also involved in the study, they were also given questionnaires to fill in. Each teacher was given the questionnaire before the constructivist learning event began and each one completed it individually. My aim in administering the questionnaire to the ICT teachers was to validate and authenticate (or refute) the information that the pre-service teachers had given me about their conception of teaching and learning with the use of computers at ISCED. The structure of their questionnaire was also divided into three sections (pedagogical, technical, and organisational), with three questions in each section. I collected both questionnaires and retained them for purposes of analysis.

3.3.3.2 Interviews

Face-to-face interviews were conducted with the ICT teachers and with the pre-service teachers. The interview schedule contained semi-structured questions that gave the researcher opportunities to probe participants for more information. The questionnaire contained a total of nine questions, divided into three sections (pedagogical, technical and organisational). Both the ICT teachers were involved in the interview process. The pre-service teachers were interviewed in focus groups. (The interview schedule is contained in Appendix 3.2.)

Interviews with the pre-service teachers

All twenty-one pre-service teachers participated in the interview sessions. The interview sessions took the form of face-to-face interviews with the researcher. The pre-service teachers were divided into four groups with five students in three of the groups and six students in the remaining (fourth) group. The interviews were conducted after the learning event had been completed. All interviews were recorded on video camera, and all interview discussions were later transcribed for analysis. Each interview session with the pre-service teachers lasted about two hours. The aim of the interviews was to elicit the opinions of the pre-service teachers about the constructivist learning that they had experienced, and to probe for information about how constructivist teaching with computers might be applied in schools in practice.

Interviews with the ICT teachers

Both ICT teachers participated in the interview sessions. After the completion of the interviews, I conducted face-to-face interviews with both ICT teachers. Each interview lasted for about one hour. These interview sessions were also recorded on video camera and all discussion was also later transcribed for analysis. My aim in interviewing the ICT teachers was to elicit their views about (1) the practical application of the constructivist learning event that had been administered to the pre-service teachers, and (2) possible future applications of computers in the Computers for Education course.

3.3.3.3 Observation checklist

While the pre-service teachers were working on the constructivist learning event, the researcher and the two ICT teachers participated in the observation process as participant observers. An observation checklist was used by all the participant observers to observe and assess the pre-service teachers while they worked on their constructivist learning event and during their individual PowerPoint presentations. The observation checklist (as mentioned above) was divided into three sections that dealt with the pedagogical, technical and organisational dimensions respectively of the study. The activities that the participant observers looked at with special attention included the three dimensions noted above.

With regard to the pedagogical dimension, the participant observers noted (1) whether the learners sought assistance from the teacher or the researcher and (2) what resources the learners used to complete their tasks.

With regard to the technical dimension, the participant observers noted the respective degrees of efficiency with which the pre-service teachers were able to use the PowerPoint program and the keyboard and mouse when typing their documents, and their individual levels of expertise and facility while surfing the Internet.
For the organisational part of the observation rubric, the researcher and the ICT teachers observed whether learners worked predominantly in a cooperative or in an individual way, whether or not they involved peers in discussions and dialogue, and the equality and effectiveness of the division of labour in the groups. All the class presentations by the pre-service teachers were video-recorded by the researcher, and the PowerPoint presentations prepared by the pre-service teachers were saved onto floppy disks for further analysis by the researcher. (See Appendix 3.3 for the observation checklist.)

3.3.3.4 Rubrics

I used two rubrics as an instrument to evaluate the learning experiences of the pre-service teachers on their task documents that were saved onto floppy disks. A total of six PowerPoint presentations were prepared by each of the six groups. Two scoring rubrics

were prepared. The first one was used to consider the observation process after the information had been compiled from the observation checklist. The second rubric was used to assess how well the task document reflected the pre-service teachers' background knowledge about malaria, the point of view of pedagogical, technical and organisational considerations. The researcher developed the rubrics in a three-scale format with the following criteria: 1 ─ Poor; 2 ─ Good; 3 ─ Very Good. (All the rubrics are contained in Appendix 3.4.)

Table 3.1 A summary of the methodology and procedures used in the study

Research methodology and procedures	
Target population	• ICT teachers of the Computers for Education course at the ISCED • All pre-service teachers at ISCED
Interviews	• ICT teachers • All pre-service teachers
Observations	• All pre-service teachers
Questionnaires	• ICT teachers • All pre-service teachers
Checklist/observations	• ICT teachers and the researcher
Task (learning event)	• All pre-service teachers
Rubrics	• The researcher assessed the observations and tasks documents of the pre-service teachers.
Time frame	• 2 weeks for data collection (September 2005)
Venue	• ISCED, Lubango, Angola

Table 3.1 summarises the methodology and procedures used in the study.

3.4 Validity

In this case study, I used two main validating strategies. Firstly, data was triangulated by means of interviews and questionnaires, and, secondly, use was made of multiple observers.

3.4.1 Triangulation of data

Data was collected from multiple sources. Instruments used for data collection included questionnaires and interviews, and an observation checklist that was used to record the activities and attitudes of the pre-service teachers as they worked on their constructivist learning events and during their PowerPoint presentation sessions.

3.4.2 Multiple observers

Two ICT teachers working at ISCED were involved in the study during the observation process. Both of them and the researcher observed the learners as participant observers. Before the start of the observation process, the ICT teachers were briefed by means of a brief verbal presentation and discussion. In the session, the researcher explained to the participant observers what was expected of them as they observed the pre-service teachers. This was done so that both participant observers would operate according to the same criteria and with the same assumptions.

3.5 Reliability

Reliability refers to “the extent to which ones findings can be replicated” (Merriam, 1988) or the “consistency of the results obtained from the data” (Lincoln & Guba, 1985). Different strategies were used in this case study to obtain consistent and reliable results. These strategies included estimations of consistency during observation on the part of all the multiple observers (the researcher and the ICT teachers). All three observers used the same structured observation checklist to collect data as the pre-service teachers worked on their constructivist learning event and made their presentations. Each participant observer made separate notes and the notes compiled by each one were discussed after each observation session so as to ensure comprehensiveness and reliability in the

combined results. The observation process was also recorded on video, and the results were compared during the transcription process (Kirk & Miller, 1986).

Consistency was also one of the criteria that were considered in the assessment of the constructivist learning event task documents and presentations. Scoring rubrics were prepared and used to assess all the task presentations that had been saved onto floppy disks by the pre-service teachers.

A semi-structured interview schedule was used in the interviewing of the pre-service teachers and the ICT teachers. This schedule enabled the researcher to probe for more information (where desirable) from the pre-service teachers and the ICT teachers. All the interviews were recorded by means of video camera.

Because this is a qualitative research study that uses a case study at ISCED in Lubango, the results cannot be generalized and applied to other settings. This is so because the assumptions and conditions that apply to this particular phenomenon cannot be exactly replicated.

3.6 Data analysis

The researcher made a qualitative analysis of the data by using the data that had been collected from the questionnaires and interviews and from observations by means of checklists and video cameras. All the data was then transcribed into a text form. The assessment results from the constructivist learning event were then analysed in terms of the three judgment criteria indicated in the scoring rubrics, namely: 1 point ─ Poor; 2 points ─ Good; 3 points ─ Very Good.

All the data collected was analysed by means of an interpretive data analysis method that involved a detailed description of the setting. This was followed by an analysis of the data in terms of themes and issues of interest in the constructivist learning process (Stake, 1995; Wolcott, 1994). The themes and issues of interest included the pedagogical, technical and organisational dimensions.

3.7 Limitations of the study

One of the main limitations encountered in this research study was the time constraints that governed the lives of the participants (the pre-service teachers). These constraints prevented the pre-service teachers from participating fully throughout the whole period that had been set aside for the research study. The study was scheduled to include two phases of constructivist learning task presentations. In the first phase, the pre-service teachers were exposed to a constructivist learning event that had been prepared by the researcher and completed with the PowerPoint presentations. In the second phase, the pre-service teachers were expected to prepare or design their own constructivist learning event and present it to their peers for assessment and comments. But because of time constraints, the pre-service teachers could only complete the second phase.

3.8 Ethical considerations in the study

According to Merriam (1988, p. 179), the ethical issues that have to be considered in every qualitative research case study, are likely to emerge at two points. Merriam divides these ethical issues into:

- Ethical issues that arise during the collection of data
- Ethical issues that arise during the dissemination of the findings

3.8.1 Ethical issues relating to data collection

A letter of permission authorising this research to be carried out in Angola was obtained from the head of the Department of the Faculty of Education at the University of Pretoria at the Department of Curriculum Studies. I wrote a letter of application to the Dean of the Faculty of Education in Angola (ISCED) to ask for permission to conduct my research in the Department of Computers for Education. Both my letter requesting authorisation for research from Pretoria and my letter of application to the Dean at ISCED contained explanations of the objectives of the research, the projected time frame of the study, the manner in which I proposed to maintain the confidentiality of the data and the steps that I would take to preserve the anonymity of the participants in the research.

The Dean at ISCED gave permission for the research to be carried out. He also made all the necessary arrangements for me to conduct the research in the university and to work with the pre-service and ICT teachers. I also composed a pro forma letter of personal consent by means of which participants could agree that they had participated voluntarily in the study, and handed copies of this letter to all the pre-service teachers in the sample and to ICT teachers. This letter also included information about the purpose of the study and procedures that I would use.

The pre-service teachers and ICT teachers were assured of confidentiality and given a guarantee that their anonymity would be preserved. They were also informed that they could withdraw from the study at any time during the research.

During the interview and presentation sessions, a video camera was used to record all discussions and presentations. Before the study began, all the participants were asked to give permission for themselves to be recorded on video and for the footage later to be used for purposes of data analysis by the researcher. All the participants gave their permission and agreed that the researcher might analyse the video recordings for purposes of data analysis.

3.8.2 Ethical issues relating to the dissemination of results

Throughout this study I made use of a straightforward English language style wherewith to write up the results of the study. The research also reflects the real and actual findings of the study. I used pseudonyms to protect the identities of the participants so that they would not be able to identify after the results had been disseminated.

3.9 Summary

A qualitative case study research method was applied in the study. Although the results of the case study cannot be generalized to other situations, the findings provide information about the training of ISCED pre-service teachers who are being trained to integrate computers with their teaching. Chapter 4 presents the results and an analysis of the data that I collected at ISCED in Lubango.

CHAPTER 4

Research findings and analysis

4.1 Introduction

This chapter contains a critical presentation and analysis of the data generated by the study. The data was obtained from the sample of first-year students (the "pre-service teachers" referred in the text) who were actively engaged in following the Computers for Education course as part of their teacher training studies at ISCED in Angola. Several data collection instruments were used in the study to collect the analysed data that is discussed in this chapter. The instruments used to collect data include questionnaires, interviews, an observation checklist, a constructivist learning event and scoring rubrics. The data, which was transcribed, coded and then summarized, identified various pedagogical, technical and organisational dimensions by using Cronjé's Model (2000) as important themes or issues. An interpretive method of data analysis was used to analyse the data.

Twenty-one pre-service teachers who were registered at the time for the Computers for Education course at ISCED voluntarily participated in the study. Before participating in the structured learning event that was central to the study, all the pre-service teacher participants attended a short introductory session organised by the researcher. In this session the researcher informed them about what they might expect during the course of the research and explain to them the aim of the research study. All the pre-service teachers and ICT teachers were asked to complete a questionnaire that was designed to gauge (1) how much they knew about computers, (2) the way in which the Computers for Education course was being taught, and (3) the methods that were being used to assess their progress in the course. Table 4.1 below tabulates biographical information gathered from the pre-service teachers and ICT teachers who participated in the study.

Table 4.1: Biographical information about the participants

Participants	**Age group**	**Gender**		**Total**
		Males	**Females**	
Pre-service teachers	**20-32**	**18**	**03**	**21**
ICT teachers	**Over 35**	**02**	**-**	**02**

4.2 Pre-service teachers' views about the ways in which computers may affect their teaching role in the classroom

The instructors who deliver the Computers for Education course being offered at ISCED use mainly traditional methods of instruction to prepare pre-service teachers. Questionnaires were given to the pre-service teachers in order to find out how they are being prepared to use computers in the Computers for Education course. The data from the questionnaires suggested the following four main issues for consideration: challenges inherent in using computers at ISCED, assessment methods and procedures used at ISCED, classroom interaction, and classroom organisation.

Since the introduction of computers into schools and other working places, the issue of how well computer users are trained to apply their knowledge and use their computers to maximum advantage has logically become an important issue. As more and more computers are introduced into the education system, teachers become increasingly enthusiastic about the potential of computers to enrich teaching and learning. In circumstances such as these teachers need to have a clear understanding of how to integrate computers with their teaching methods. In most cases, as I pointed out in previous chapters, teachers who have been trained in traditional behaviourist-style teaching methods experience the integration of computers with teaching as completely revolutionary. This happens because computer-integrated teaching removes the teacher from the centre of the didactic paradigm and entrusts learning to the active initiative of learners as they engage in solving authentic learning tasks in settings that emphasise their social and communication skills.

Among other questions in the questionnaire, pre-service teachers were asked why they had chosen to join ISCED, and why they had registered to take the Computers for Education course. Most of the pre-service teachers indicated that they had chosen to study at ISCED because they wanted to learn more about the use of computers and their applications for their future work. For example, one of the pre-service teachers said:

> "What made me to choose this course, although it was not my first choice, [was that] I wanted to learn how to use and know about technology namely computers." [Any text in square brackets is inserted by the author for purposes of clarification.]

Another pre-service teacher said:

> "I wanted this course because it is a course of the future. I can work for any institution. I love this course so much."

Other pre-service teachers offered other reasons for choosing ISCED as their first choice in career development. These pre-service teachers said they had chosen ISCED because they wanted to learn more about technology. One of them added that he liked teaching, and wanted to be able to use computers to teach his students.

> "I choose this training for curiosity since my dream was to do medicine. But I know that I made a choice to come to ISCED and I am enjoying the course and I am making a lot of efforts to leave this institution being well trained."

> "I choose this course because, first of all, I like teaching and second I would like to teach using information technology."

The response of pre-service teachers to these questions suggests that many of them entertain high hopes for the Computers for Education course. Because of this, and because of the course is relatively new in the college, it needs to be discussed and

appraised here. What follows therefore is an account of some of the challenges that pre-service teachers face in the Computers for Education course.

4.2.1 Challenges of computer use at ISCED

Access to Computers

ISCED possesses two computer laboratories, each of which is equipped with thirty computers. The computers in its laboratories are mostly Pentium 3, 800 MHz, 128MB RAM computers, all of which are connected to the Internet. All the pre-service teachers stated in the answers to questions in the questionnaires that they only have access to computers (and therefore the Internet) during routine, scheduled sessions of the Computers for Education course. For the rest, the computer laboratories remain locked for reasons of security, and also because Internet connections in southern Africa are very expensive. What happens in effect therefore is that pre-service teachers have no access to computers and an Internet connection unless this happens in the context of teaching and instruction for the course. Some of the pre-service teachers say that they have been able to use the laboratories by making special arrangements, but then only when an ICT teacher is able to be present. Here are three remarks made by pre-service teachers in response to questions:

> "I cannot use the computers at ISCED at anytime I want; sometimes I have to get permission from the coordinator if we are doing a project or other assignments. I can use it only during the class. Sometimes I go to Internet café even though this is very expensive."

> "ISCED only provide us with access during class time. But we are not allowed to get in if the coordinator is inside the computer laboratory."

> "The computer laboratory at ISCED is usually closed for students if they are not attending class."

Four of the respondent pre-service teachers said they had their own computers at home. This presumably means that they are not completely reliant on computers at ISCED. One respondent wrote:

> "I use computer at ISCED during class time only. After school I use my computer at home."

Internet connectivity

Although all the computers at ISCED are connected to the Internet, the Internet connection is not available after class hours. When the ICT teacher was quizzed as to why the pre-service teachers could not use the Internet after class hours, he said that the Internet connection is very expensive and that it can therefore only be used when it is absolutely necessary to do so, and that is during class hours only. The respondents who indicated that they had computers at home also indicated that they have no home Internet connection for the same reason (it is prohibitively expensive in Angola). One of the pre-service teachers said:

> "I do have a computer at home but [it is] not connected to the Internet."

Seventeen of the respondents asserted that if they needed to work on a computer at any time after college classroom hours, and if they needed to use the Internet, they would go to the Internet café. Some of the pre-service teachers explained that having to go to the Internet café, especially if such visits had to be made on a daily basis, presented its own problems. What made frequent visits to the Internet café problematic was once again the cost of using such services on more than an occasional basis. Because of such difficulties, most pre-service teachers have limited access to Internet services. This deprives them of essential experience and opportunities for practice, as well as freely available access to information on the Internet. In the absence of an Internet connection, student resort to library books as the last remaining option. Some of the statements that such students made include:

"I have to go to the Internet café and this is not easy because I have to go after school hours. Sometimes I go to Internet café if I have some money."

"I go to the Internet café but not always."

"I sometimes go to the Internet café if I have some money. "

Computer programs and skills

According to the Computers for Education syllabus for first-year students at ISCED, all pre-service teachers are required to learn how to use basic computer application programs. These basic computer application programs include Microsoft Word, Microsoft PowerPoint, Microsoft Excel, Microsoft Access and the Internet. Data from the pre-service teachers' questionnaire showed that all twenty-one pre-service teachers said that they are able to navigate their way around the main basic programs taught at ISCED. Two of the pre-service teachers said they could use the basic programs, that they could surf the Internet, and that they possessed additional knowledge about how to use Microsoft Outlook (a program for which no instruction is offered at ISCED). All the pre-service teachers stated that they used the computers mainly to type out their assignments, to practise typing, and to search for information they would need in a forthcoming Computers for Education class.

4.2.2 The assessment process used at ISCED

According to Brooks and Brooks (1993), teachers who engage in the assessment of learners in a constructivist classroom should try to understand the topics with which students are engaged and what students may currently be thinking instead of merely reacting negatively. Through non-judgmental questioning, teachers should try to lead students to construct new understanding for themselves while they acquire new skills in whatever they may be doing. Constructivists believe that "assessment should be used as a tool to enhance both the student's learning and the teacher's understanding of the student's current understanding. It should not be used as an accountability tool that makes some

students feel good about them and causes others to give up" (Brooks and Brooks, 1993, p. 85).

Below are three basic principles that teachers need to take into account during assessment processes in a constructivist classroom (Jonassen, 1991).

- Assessment should be both outcome-based and student-centred.
- Assessment should incorporate self-evaluation, peer-evaluation and teacher evaluation.
- Performance standards need to be developed (the criteria used in rubrics, for example, need to be established).
- Students should be videotaped as they work, and such tapes should form the basis of performance assessment.
- The focus on assessment should be on originality rather than on regurgitation of memorised information. It is important to evaluate how learners go about constructing their own knowledge rather than the product itself.

The data accumulated from the questionnaires administered to pre-service teachers at ISCED indicates that the most commonly used method of assessment involves paper and pencil tests. The pre-service teachers indicated that they were usually given written tests at the end of the module or semester. On such occasions they were tested by means of multiple-choice questions and essays that they were required to complete. Sometimes they were given projects to complete individually or in groups.

Tests

The kind of tests that the ICT teachers at ISCED prepare often include long essay-type questions and the short-answer questions such as multiple-choice in which students are required to insert information into blank spaces. Four pre-service teachers said that their ICT teachers always gave them essay-type questions which were always administered to learners at the end of the semester or module. Assessment methods of this type gave students opportunities to think about the assigned topics and respond with their own. In structured questions such as multiple-choice questions, however, which have either only

a right or a wrong answer, students are forced to respond by selecting only one option — a method that gives students no leeway to think about and construct their own approach. One of the learners, for example, said:

> "The teacher uses essay-type questions and this give students the chance to say their own ideas."

> "The teacher assesses us with [an] essay when we are done with the module most of the time."

Ten other pre-service teachers indicated that they had been given multiple-choice questions on which they were required to fill in blank spaces. Some of them said they liked short-answer questions because they were easy to answer. One of the pre-service teachers, for example, said:

> "The teacher gives us tests which have multiple-choice questions at the end of the module and I prefer multiple-choice questions because they are easier to answer during tests."

Projects

Pre-service teachers are occasionally given projects to complete as a form of assessment. Such projects are set at the end of the module concerned because pre-service teachers have to gather their own information to complete these projects, and that takes time. The pre-service teachers indicated that they enjoyed working on these projects because they give them confidence in the subject, they got to know the subject well, and they offered opportunities for sharing ideas in groups. The ICT teacher decides how the project should be carried out. Sometimes a project needs to be completed by the individual alone, and sometimes it is completed in groups. Thus, for example, when projects are being completed in groups, a comprehensive and detailed project report needs to be submitted by the students. This report needs to include a critically appraised form of all the

information that students have managed to amass. Remarks from students about this topic included:

> "The teacher gives us practical work sometimes to complete as a group. This will give to us the opportunity to share ideas with each other."

> "It depends on the section that we are studying for the teacher to decide what he should do. But normally the teacher uses group or individual projects."

Four pre-service teachers noted that they had always been given projects on which to work both individually and in groups. For each of these projects, the teacher required a relatively brief project report. For example:

> "We are sometimes given individual projects that we are supposed to complete at the end of the module. This helps us to understand better what is happening. I just need to pay attention to what I am doing."

Confirmation of what pre-service teachers had said in their questionnaires about how they were being assessed is evident in the data. The ICT teachers indicated that they always assessed the pre-service teachers by giving them tests at the end of the module. These comprised multiple-choice questions for which students needed to fill in missing information, essay-type questions, and sometimes projects. The ICT teachers agreed that they occasionally set projects for pre-service teachers because projects of this kind gave pre-service teachers more opportunities to engage in practical hands-on activities and experience. This is reflected in the following statement by a teacher:

> "I am more interested to give to them a practical work because they are computer students for education and they have to get prepared to teach using computers when they leave ISCED."

4.2.3 Classroom interaction

According to Cunningham, Duffy and Knuth (1993), "interaction in a constructivist classroom is viewed as the primary source for the cognitive constructions that learners can use to build on and make sense of the world when doing problem-solving tasks" (Cunningham *et al*., 1993). Individuals seem to develop more readily during teaching and learning when a combination of dialogues and negotiations are used to discuss and elucidate meaning. According to Brooks and Brooks (1993), teachers need to emphasise the use of dialogue and negotiation in constructivist classrooms by encouraging learners:

- to engage in dialogue with both their teachers and one another
- to enquire by asking thoughtful, open-ended questions and encouraging learners to ask questions to one another (Brooks & Brooks, 1993, p. 108-110).

With regard to the use of classroom interaction in the ICT course, twelve pre-service teachers said that only their teacher teaches them, and students can only ask questions about subject matter at the end of the lesson. Two students, however, added:

> "It depends on the teacher's plan. But our teacher normally comes to the class and teaches only."

> "Normally my teacher teaches us in the classroom. We do not engage in class discussion that often."

Five of the pre-service teachers said that for most of the time they were not involved in any discussion process. They intimated that they usually just sat and listened while their ICT teacher spoke. One of these students remarked:

> "I do not see any discussion in the computer course because we have to rely on the teacher's teaching."

It may thus be said that the use of classroom interaction to promote the objectives of teaching and learning is rare at ISCED. The most common method used by the ICT

teachers is teacher-centred, and dialogue between teacher and learners is infrequent. The ICT teacher does the teaching and the pre-service teachers listen to him. The ICT teachers pose questions and the pre-service teachers have to answer them. This form of teaching process is of a type that I described earlier in this text as "traditional". It certainly conforms to a basically behaviourist style.

From time to time, however, the teaching undertaken by the ICT teachers at ISCED and those include interaction. One form of interaction that does take place is when teachers openly commend students who have produced good work. Most of the pre-service teachers in the Computers for Education course agreed that their ICT teacher appreciated their work. The remarks of two students confirms this:

> "Normally the teacher congratulates the good students."

> "My teacher used to congratulate the students who did well. If this is not me, I just feel that next time it can be me."

4.2.4 Working organisation

In a constructivist classroom, by contrast, teacher and students share responsibility and decision-making and demonstrate mutual respect (Brooks, & Brooks, 1993). While learners work primarily in groups in a constructivist classroom, tuition may sometimes also be individualised or undertaken in pairs.

To questions concerning the organisation of the computer classes, the majority of the pre-service teachers stated that, for the most part, they work in groups. Seventeen pre-service teachers affirmed that they "always" worked in groups and that this suited them because it enabled them to share ideas among themselves. One of the teachers said:

> "I prefer working in groups because it helps us to get more experience; We share ideas. In short, it turns things more creative."

Four pre-service teachers, however, maintained that they preferred to work alone because working individually seemed to them to be easier, and because there are always some members of a group who do not participate.

> "I prefer individual work because in group work there are many people who do not work hard, expecting that the others will do, thus exploring [exploiting?] the others' efforts."

More often than not, the ICT teachers took upon themselves to allocate students to particular groups although they did occasionally allow students to choose the groups in which they wanted to work. Eleven pre-service teachers stated that it is the ICT teacher who normally arrives students into groups. Ten pre-service teachers said that they always selected those with whom they wished to work in groups.

> "It depends on the teacher plan. He can select or send the students to group them."

In general it may be said that students generally preferred to work in groups irrespective of who arranged the composition of each group.

4.2.5 Summary

One may say in conclusion that an analysis of data reveals that the teaching and learning process at ISCED is mainly teacher-centred with some inclusion of learner-centred elements. This means in practice that the teaching undertaken by the ICT teachers may be described in terms of two of the quadrants of Cronjé's paradigm: in this case, the behaviourist and constructivist quadrants. One may characterise the paper and pencil tests and the multiple-choice questions favoured at ISCED as essentially behaviourist in application and educational value. By contrast, the projects that the ICT teachers assigned at the end of each module provided pre-service teachers with opportunities to demonstrate their talents and individuality with regard to learning styles and aptitude for teamwork. This kind of assessment process is more orientated towards the behaviourist quadrant in Cronjé's model.

Although the evidence showed that the ICT teachers seldom used dialogue and negotiation as supplementary teaching devices, the pre-service teachers frequently engaged in discussions about matters of common interest, and were able to negotiate agreement among themselves when necessary. Discussion and negotiation thus gave participants opportunities to present their own ideas, to hear the ideas of others, and to reflect upon and consider potential courses of action as they participated in negotiating agreements that might be satisfactory to all parties concerned. As far as the issue of technology is concerned, the accumulated data shows that access to either of two computer laboratories was severely restricted outside of the scheduled classroom lectures. With a few exceptions, the two computer laboratories were only opened to pre-service teachers for the purpose of scheduled lectures. While some students tried to offset the disadvantage of not being able to practise their skills outside of lectures, the means to which they resorted to compensate for this deficit were anything but satisfactory. Some students, for example, bought time at Internet cafés but could not do this more than infrequently because of the expense involved. Other students had personal computers at home on which they could practise their skills even though none of them possessed a home Internet connection because of the prohibitive expense involved. Undoubtedly though the minority who were able to practise computer skills at home enjoyed a definite advantage over those who possessed no such facility. While time spent practising computer skills in an Internet café was also undoubtedly helpful, the expense involved curtailed the amount of time that students could spend in such places. Time spent in Internet cafés cannot therefore be regarded as a significant compensatory measure.

4.3 The implications of an instructional approach that focuses on constructivist pedagogy and that uses computers for pre-service teachers

In this case study, the research are designed, prepared and implemented a constructivist learning event for the sample of participating pre-service teachers in order to assess the extent to which the participants were able to integrate computers into a teaching and learning event. The topic chosen for the learning event was malaria and the effect that it

exerts on the lives of the people in Lubango in Angola. Malaria is a serious and often fatal endemic disease that occurs in most African countries. Malaria was chosen as the topic for the learning event because it provides an indubitable example of an authentic, real-world condition in the lives of the pre-service teachers in the sample. This single learning event was duly administered to the pre-service teachers. The students were divided into six groups; three of the groups each contained three students while the remaining three groups each contained four students.

The pre-service teachers were expected to complete the constructivist learning event by searching for their own information resources on the Internet and in the library while at the same time gathering pertinent information from the staff of the local hospital in Lubango. Each of the groups was then required to present its own findings in class by making individual presentations, and all the pre-service teachers contributed to assessment and discussions during the presentations.

Table 4.2 below tabulates the data from the observation checklists compiled by the researcher and by the ICT teachers who assisted her as they observed the pre-service teachers at work on their constructivist learning event and made notes about individual and group performances in terms of the rubrics that the researcher had assembled. The learning event began with preparation, discussion, negotiation and searches for information and data. It continued with the putting together of PowerPoint slides and concluded with the presentation of each group's work. The researcher subsequently analysed the data in terms of the three main dimensions that I have mentioned above (the pedagogical, technical and organisational dimensions applicable to the research).

4.3.1 Pedagogical issues generated by the use of computers

Formal observation of the students while they were engaged in completing the constructivist learning event was carried out by the researcher who was assisted in this task by the two IT teachers from ISCED, who had consented to be part of the process. The observation process was guided, as has been mentioned before, by rubrics that described the various categories in which observations had to take place. What these

observations showed is that from a pedagogical point of view, the pre-service teachers from ISCED performed well in the constructivist learning event in categories which required them to demonstrate their skills by using their background knowledge, by searching for and collating whatever resources they need it for the project, by asking for assistance where they were unable to cope by themselves, and in planning whatever activities were necessary for completion of the task. Table 4.2 below summarises and tabulates the scores that each group obtained in the assessment protocols that dealt with the pedagogical dimension of the research. The scores in all the criteria in this dimension confirm that the performance of the three quarters of the pre-service teachers was "very good" (indicated by three points), and that the performance of one quarter of the pre-service teachers was rated as "good" (two points). All the pre-service learners in the sample performed well. In the sections that follow below this table I will discuss each of the criteria in turn and comment on the performance scores.

Table 4.2: How the six groups were rated in terms of pedagogical criteria

Description	**Groups 1 to 6**					
	1	2	3	4	5	6
What was the previous knowledge of the pre-service teachers on the topic of malaria?	3	2	3	3	3	3
Did the pre-service teachers manage to find their own resources and collect data?	3	2	3	3	2	3
Did the pre-service teachers ask for assistance or guidance while trying to find the information that they needed?	2	2	2	2	3	2
Did the pre-service teachers plan their own activities for the completion of the task?	3	3	3	3	3	3

Previous knowledge of the pre-service teachers

Five out of a total of the six groups of pre-service teachers performed *well* in the use that they made of their pre-existent knowledge to prepare their tasks and activities and to apply such pre-existent knowledge to the topic of malaria. In this context, doing *well*

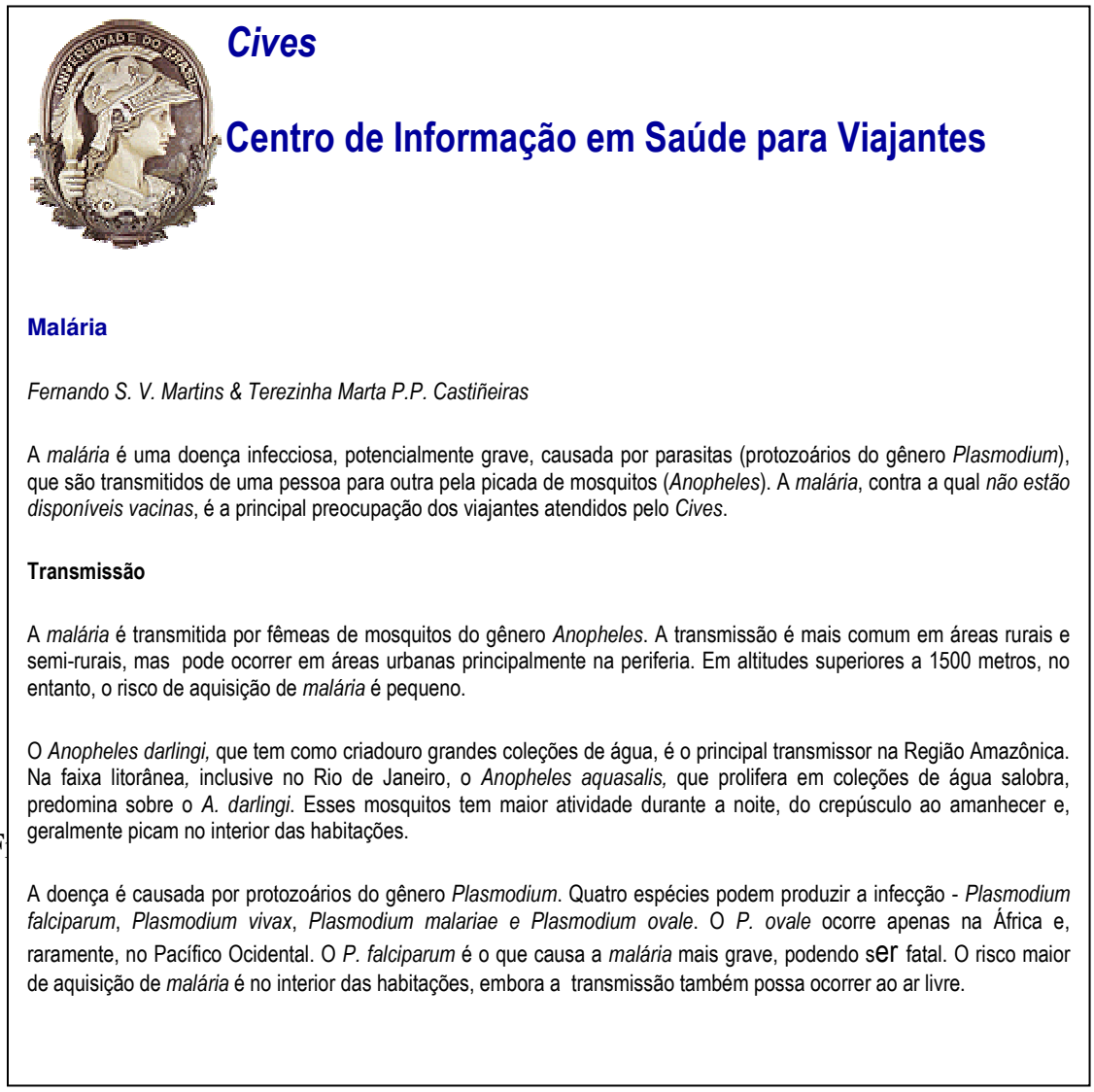
meant that their work was well structured and well documented, that their ideas were clear, coherent and well written. The observers were able to make this assessment as they observed the quality of the slides and the manner in which the slides were presented during the presentation session.

The background or pre-existent knowledge about malaria that the students possessed made it easier for them to present the subtopics in which they introduced the topic of malaria, explained what it is, how it is caused, the symptoms that malaria produces, how the illness is transmitted to human beings, how it is treated, and how it may be cured. After they had presented the subtopics, the participants showed the audience a selection of the pictures that they had found on the topic of malaria. My general impression is that nearly all the students found it easy to accomplish this particular task.

Use of a variety of resources

Observation of the *variety* of resources used by students to complete the constructivist learning event showed that four groups worked well and scored very well (three points). This means that they used a variety of resources used to collect the data needed to complete the learning event. Among the resources they used was the Internet on which they were able to locate, open and use websites from the World Health Organisation (2004). These websites gave them access to the latest current information about how malaria affects people in general and in Angola in particular. (A frame from one of these websites is included in figure 4. 1.) These pre-service teachers also use their social and negotiating skills to obtain more information from the local hospital in Lubango. They prepared their own questions in advance and then competently conducted an interview with the medical director of the hospital. In the interview they asked his opinion about the prevalence of malaria in Angola, the age group that is most affected by malaria, and what his advice might be to people who live in a malarial area such as Lubango. The pre-service teachers also included information that they had obtained from local newspapers. The articles they located discussed malaria in Lubango and Angola in general, and the severity of the condition. One of the groups also made use of the library facility to obtain supplementary information. The search for information was therefore competently

undertaken and this competence and mastery was reflected in the high standard of the products that the pre-service teachers produced at the conclusion of the constructivist learning event.



Cives

Centro de Informação em Saúde para Viajantes

Malária

Fernando S. V. Martins & Terezinha Marta P.P. Castiñeiras

A *malária* é uma doença infecciosa, potencialmente grave, causada por parasitas (protozoários do gênero *Plasmodium*), que são transmitidos de uma pessoa para outra pela picada de mosquitos (*Anopheles*). A *malária*, contra a qual *não estão disponíveis vacinas*, é a principal preocupação dos viajantes atendidos pelo *Cives*.

Transmissão

A *malária* é transmitida por fêmeas de mosquitos do gênero *Anopheles*. A transmissão é mais comum em áreas rurais e semi-rurais, mas pode ocorrer em áreas urbanas principalmente na periferia. Em altitudes superiores a 1500 metros, no entanto, o risco de aquisição de *malária* é pequeno.

O *Anopheles darlingi,* que tem como criadouro grandes coleções de água, é o principal transmissor na Região Amazônica. Na faixa litorânea, inclusive no Rio de Janeiro, o *Anopheles aquasalis,* que prolifera em coleções de água salobra, predomina sobre o *A. darlingi*. Esses mosquitos tem maior atividade durante a noite, do crepúsculo ao amanhecer e, geralmente picam no interior das habitações.

A doença é causada por protozoários do gênero *Plasmodium*. Quatro espécies podem produzir a infecção - *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae e Plasmodium ovale*. O *P. ovale* ocorre apenas na África e, raramente, no Pacífico Ocidental. O *P. falciparum* é o que causa a *malária* mais grave, podendo ser fatal. O risco maior de aquisição de *malária* é no interior das habitações, embora a transmissão também possa ocorrer ao ar livre.

F

Figure 4.1: A web page about malaria from the website of the World Health Organisation (2004)

Support during preparation and presentation of the task documents

In this part of the assessment, the three observers scrutinised how well the pre-service teachers took responsibility for managing the conditions under which they worked on the constructivist learning event. Five of the groups looked for support or guidance from the

teachers and the researcher. This indicated that they had understood the instructions that had been given to them at the beginning of the study, and were therefore not at a loss when they encountered obstacles or when they needed help or guidance from the researcher. In a constructivist environment the teacher outlines the project and then remains in the background without actively interfering or imposing his or her will on the students. Students are left alone to organise their tasks and construct their own meaning as they grapple with a learning event whose outcome is to some extent already well understood by the teacher. The constructivist teacher outlines the objective to be attained with maximum clarity, but then leaves the students to realise the objective without active interference or imposition. What we observed in these circumstances was that the pre-service teachers were very skilful at managing the tasks that they needed to accomplish and that they knew when they needed to ask for advice, assistance or guidance. We also observed how the students discussed the stages of the project as they engaged in its completion. They discussed matters occasioned by problems, planning, allocation, progress and the execution of the tasks as the need arose. All this was duly noted and recorded by the observers in accordance with the pre-designed rubrics that the researcher had created. Each group produced what it thought was the best solution to the problem of malaria in Lubango, and each was valid in its own way and in its own context. All of the five groups scored two points because the discussion had to be initiated by the researcher.

Planning of the activity or task for the learning event

This section deals with the findings about the way in which the pre-service teachers planned their particular task activities from the moment when they received their instructions from the researcher. Each group performed well and thus scored three points each. Each of the groups tried in their various ways to implement all of the instructions they were given as best they could.

The excellence of the organisation in the groups was evident initially from the fact that they took pains to discuss among themselves what they needed to accomplish. During such discussions they negotiated responsibility for the various activities that had to be undertaken and allocated responsibility among themselves for the performance of these

activities. Members of groups also committed themselves to the performance of various tasks, and the quality of the commitment thus made could be deduced from the timely completion of the tasks that each person undertook to perform.

In all the categories of the pedagogical dimension that we used to assess the students, the students performed well or very well. Because all of the students understood what a serious problem malaria is and because they were living and studying in a malarial zone (Lubango), they had already amassed a considerable background knowledge about malaria. It was not therefore difficult for them to focus on the direction in which their various searches for information should move. Since the references available in the ISCED library were somewhat dated, the students correctly relied on Internet sources to obtain the most current information available in the world. They also displayed admirable ingenuity in solving problems that arose during the course of the learning event, and in judging the relative value and utility of the information that they garnered on the Internet.

4.3.2 Technical issues arising from the use of computers

The ICT teachers and researcher observed that the students made effective use of the technology at their disposal. Observational data confirming this point of view is tabulated in Table 4.3 (below). Almost all the pre-service teachers managed to use whatever computer skills they possessed in an effective way to complete the constructivist learning event.

Table 4.3: Results of the six groups observed in this study in technical issues

Description	**Groups 1 to 6**					
	1	**2**	**3**	**4**	**5**	**6**
Does the presentation run without problems (the slide show presentation sequence)?	3	3	3	3	3	3
Can the learner integrate different features (such as PowerPoint labels and the insertion of pictures)?	3	2	3	3	3	3
Can the learner use the keyboard and mouse	3	3	3	3	3	3

effectively?						
Can the learner use the Internet effectively to search for information? Can the learner use the email facility?	3	3	3	3	3	2

The PowerPoint slide show presentation

All six groups worked very well with the PowerPoint presentation slides and they all scored three points (the maximum) for this activity. This meant that they possessed good computer skills. Most of the groups showed between ten and eleven slides while only one group showed eight slides. Since all of them were beginners in this form of instruction, it was both encouraging and gratifying to see that all of them performed as though they were experienced in this kind of instructional process. All the groups used the PowerPoint slide show presentation program effectively.

Efficient use of programs — use of pictures, animations, clipart

Most of the pre-service teachers demonstrated competence in this aspect of computer application skill. None of the pre-service teachers needed any assistance in using the computer programs; they all managed to use Microsoft Word features such as formatting, paragraphs, clipart, tables and the application of different font sizes. They are also able to use Microsoft PowerPoint animations and to import pictures and tables into their presentation slides. The slide shown in Figure 4.2 demonstrates how well the pre-service teachers were able to use tables in their presentation slides.

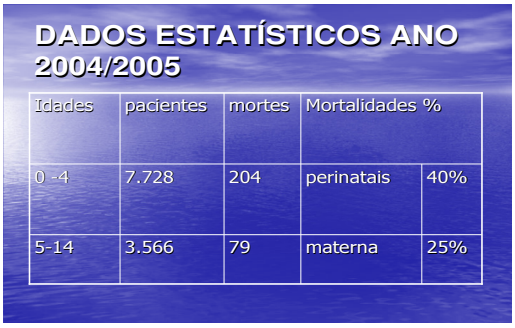


Figure 4.2: Slide showing a table with information obtained from the hospital

Manipulation of the keyboard and mouse

The observers rated the students' ability to use and manipulate the keyboard and mouse effectively as *good*. All the members of the groups were able to type at an acceptable or good speed and each one was able to use the keyboard effectively in the presentation sessions. The pre-service teachers could also use navigational keys on the keyboard without assistance or guidance.

Internet surfing and email

The participants' ability to "surf" the Internet for information was *very good*. Five of the groups scored three points on the scoring rubric for this activity. This is especially impressive in the light of information that one of their ICT teachers gave us during an interview session. He told us that although he had taught the students how to search for information on the Internet, none of the participants had been able to practise doing so in classroom sessions (although they had conceivably used other extra-curricular opportunities to practise this skill). In the process of looking for information, some of the students succeeded in finding good Portuguese language information about malaria and its implications. All six groups succeeded in locating good-quality information on the Internet and they all subsequently used this information in their texts. Five of the six groups also found pictures which they that pasted into slides. Some of the pre-service teacher's added information obtained from Portuguese-speaking countries such as Brazil and Mozambique that are also seriously affected by malaria.

Other noteworthy application skills demonstrated in the course of Internet surfing were the ability to include the dates of searchers undertaken as well as the URLs of sites from which they had collected information for their reference slides. It is worth noting that although the participants were competent enough to find relevant information on the Internet, they did not use the e-mail facility to send information to one another. This deficiency should be assessed in the context of the understanding that they were not required by the researcher to use the e-mail facility in this part of the study. The data

from the questionnaire does however confirm that the pre-service teachers used the e-mail facility provided by Internet cafés on a fairly regular basis.

4.3.3 Organisational abilities of the pre-service teachers

The participants in the sample were also assessed by the observers for their organisational skills and abilities in terms of the assessment protocols governed by the rubrics created by the researcher. In general the observers found that the organisational skills demonstrated by the students as they completed the constructivist learning event were of a high order. The students proceeded to manifest their organisational skills by negotiating tasks and activities among themselves in a clear, logical and competent way before proceeding to the practical part of the constructivist learning event. The criteria for organizational competence for which the observers were on the lookout included the ability to work cooperatively rather than individually, a capacity for discussing and sharing relevant ideas, an ability to present completed activities in a clear, indecisive and attractive manner, and skill in dividing the work up among themselves (the division of labour). Table 4.4 summarizes the scores that the pre-service teachers attained as they worked on their learning event.

Table 4.4: Scores obtained by each of the six groups for their organisational skills

	Groups 1 to 6					
Description	**1**	**2**	**3**	**4**	**5**	**6**
Did the learners work cooperatively in groups or alone (individually)?	**2**	**3**	**3**	**2**	**3**	**3**
Did the students discuss important matters among themselves and engage in dialogue with one another?	**2**	**2**	**3**	**2**	**3**	**2**
How well did the students present their activities?	**2**	**3**	**2**	**3**	**3**	**3**
Was the negotiated division of labour for the constructivist learning event and presentations fair and equitable?	**3**	**3**	**3**	**3**	**2**	**3**

Cooperative or individual work

The ability of a learner to work cooperatively with others is vitally important in constructivist learning contexts ─ even though learners are sometimes required to work alone (individually). Observations made by the researcher and the two IT teachers indicated that four of the groups of participants possessed this skill to a very high degree. This could be deduced, firstly, from the fact that the groups who performed well encountered no obstacles at all when it came to dividing themselves into their respective groups. Once this had been done, one member in each of the groups would by common consent take over the position of leadership in the group concerned. Once they had successfully concluded negotiations to allocate tasks and responsibilities, the students visited the local hospital in Lubango to collect data about malaria from the staff of the hospital. Before leaving for the hospital, each group prepared a short questionnaire of questions that they intended to present to the medical superintendent of the hospital (assuming that they would be successful in obtaining an interview). Once they had compiled their questions, they all left for the hospital together. Once the interview was under way, one member of each group would ask questions on behalf of all the other members of the group. The remaining members of the group attended to recording the answers that the doctor provided. During the presentation of their slides all the members of groups took equal turns to present the information. One may deduce that the level of success and competence that the groups demonstrated as they worked together in the Computers for Education course exerted a positive effect on how these pre-service teachers perceived the value constructivist learning events.

In the two groups that scored two points each, the members of the groups negotiated cooperatively to divide the work equitably among them, but when they got to the hospital the leader of the group asked the questions *and* recorded the answers given by the medical superintendent. This left nothing for the remaining members to do! Similarly, the presentation of slides was dominated by a few members in these groups until they were effectively stopped by the remaining members of the group. This so embarrassed one

member of one of the groups that he then sat with his hands over his eyes! Figure 4.3 below shows the pre-service teacher who had to be reminded that there were also others who wanted to take part in the presentation.

Figure 4.3: The pre-service teacher covering his face after he had been reminded that there were also others who wanted to take part in the presentation.

Discussions and dialogue with one another in the groups

During the learning event preparations the pre-service teachers discussed the event with each other, but not with the other groups. Four of the six groups spoke very little and exchanged very little information after the researcher had introduced them to the task. Even when they went to the hospital for the interview with the medical superintendent, they communicated very little indeed among themselves or with the staff at the hospital. Since these are groups communicated very little among themselves, the task of presenting the work in presentation sessions fell to one member of each group. Because of this, each of these four groups scored two points each (rather than the maximum possible score of three points that indicate excellence).

The other two groups which were awarded the maximum possible score of three points each communicated a great deal within their groups. They discussed their topic within their groups. Different group members also offered verbal suggestions as the groups prepared their list of interview questions for their forthcoming interview with the medical superintendent at the hospital. The presentations that these groups made were also very

well organised. Each member of the group concerned was given one or more opportunities to participate in discussion and to present findings, ideas and comments to the audience.

Presenting the activity (delivery of the task)

Finding the best way to solve a particular problem is not always an easy task. Sometimes it takes a long time and a great deal of effort for all members of a group reach agreement about what should be done and the manner in which it should be done. The data collected by the researcher and the other observers shows that conflict arose in groups as members tried to reach consensus about who would present what. Since the performance in four of the six groups could be designated as very good, these groups each received three points for their presentation activities and delivery. During the presentations, each member of the group took responsibility for one or another of the elements of the presentation. The respect that members of these groups also showed for one another as they collaborated in the various phases of the learning event was also quite conspicuous. The active involvement of all members in each of these groups was evident in the behaviour of the leaders of the groups who solicited contributions and ideas from every member in each group at exception. In addition to this, all members of the group were detailed to make notes about the doctor's answers to the questions that he was asked while the leaders themselves actually asked the questions. Mutual respect and consideration were thus evident in both these two groups. This kind of mutual respect was also discernible in the groups during the presentations as all the members participated fully in the presentations and discussions.

Division of labour

One of the groups did not perform as well as the others in the division of labour. All five groups managed to divide their work equally well within the groups and worked well together. As I mentioned earlier, the ability of the teams to work effectively in groups could be a skill that participants have already learned as a result of their habits of organisation and communication acquired in their teacher training and normal classroom practice. In any event, the teams had no trouble in selecting their preferred leaders.

During the completion of the learning event, they also demonstrated continuous respect and consideration for one another, and completed all the requirements of the learning event in the time allotted to them.

4.3.4 Content knowledge in the PowerPoint presentation slides

Once I had completed the observation process with the help of two participant observers, I decided to make appraisals of the content that the pre-service teachers presented in their PowerPoint presentation slides by means of a marking schedule. After making arrangements for all the presentation slides from the six groups to be printed, I scored them according to rubrics that incorporated a three-point scale to convey the following performance values: 1 poor, 2 – good, and 3 – very good. Table 4.5 shows a summary of the results obtained from a consideration of each question in the rubric, and the points awarded.

Table 4.5: Points scored by each of the six groups for their PowerPoint presentation task documents (in terms of questions contained in the rubric)

	Groups 1 to 6					
Assessment question	**1**	**2**	**3**	**4**	**5**	**6**
Did the students show a high level of knowledge about and understanding of the topic task?	**3**	**2**	**3**	**3**	**3**	**3**
Did the students mention the problem of malaria in any other country than Angola?	**2**	**2**	**2**	**2**	**2**	**2**
Did the students give evidence of ingenuity, creativity and effort in their presentation of the solution of the task (in pictures of the mosquito, for example, or pictures of affected people and the distinctive life cycle of malarial mosquito?	**2**	**2**	**2**	**3**	**2**	**3**

Knowledge level and understanding of the topic

This is related to the students' level of understanding of the topic of malaria as *very good*. They based this rating on the quality of the PowerPoint slides that the pre-service teachers screened during their presentations. The five groups that scored three points each demonstrated an extensive, in-depth and intelligent knowledge of the topic. The pre-service teachers made use of various examples to support their ideas, and showed pictures and diagrams that they had downloaded from the Internet to explain the life cycle of the malaria parasite as it travels from primary host to secondary host. I selected the picture below as the best illustrative example from the Internet. Figure 4.4 shows the life cycle of the mosquito parasite.

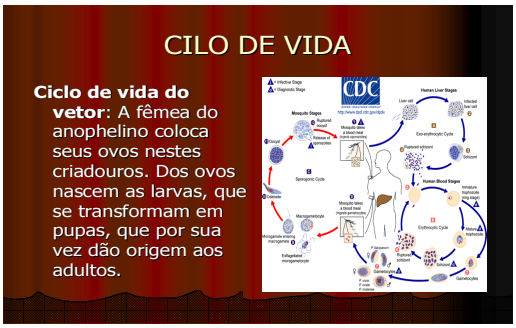


Figure 4.4: Life cycle of the mosquito parasite

Evidence of creativity in explaining malaria

The pre-service teachers only mentioned Brazil and Mozambique as additional examples of malarial countries in the rest of the world as they dealt with the topic.

The pre-service teachers were also rated on the degree of creativity and other abilities that they showed while completing the constructivist learning event. Most of the pre-service teachers showed a high level of creativity if one considers the short time they had to complete the task. They managed to incorporate different pictures into their presentation slides to elaborate points that they were making (some of these pictures have been reproduced in figure 4.6).

Figure 4.6 includes a photograph of the female Anopheles mosquito that causes malaria, and one of a child doing the blood test that indicates the presence or absence of the malarial parasite in the human body.

Figure 4.5: Pictures used by the members of group 4.

4.3.5 Summary

Universities in Angola are beginning to understand that ICT may have a beneficial impact on the lives of people in their daily activities. My hope therefore is that the results of this study will provide additional evidence for the educational potential of ICT in schools. The importance of ICT in modern education makes it essential for all teachers to have the ability to integrate computers (and forms of ICT) with their teaching before they go out into the schools.

In order to make the study relevant, I compiled my instruments and rubrics in terms of the following three dimensions or criteria that I will now discuss

- Pedagogical dimension
- Technical dimension
- Organisational dimension

Pedagogical dimension

Observation of the pre-service teachers showed that they performed well in the constructivist learning event in which they were required to give evidence of their skill in (1) utilising their own background knowledge, (2) collecting all the information and resources that they needed from various sources and people, (3) asking for assistance where they needed it, and (4) planning their activities in such a way that they would successfully complete the constructivist learning event.

They demonstrated a high degree of skill in using their existing background knowledge to present PowerPoint slides, arrange pictures for illustrative purposes, and use tables, text and Internet information in of support their ideas. They also managed to use their computer skills to search for relevant Internet information to supplement their resources. Though some of the pre-service teachers were apparently too shy to ask the researcher for assistance directly, they nevertheless proved that they could manage their own learning tasks and plan efficiently for the implementation of the learning event.

Technical dimension

In the technical dimension, the pre-service teachers showed a high degree of competence in the application of their computer skills. They managed to project the PowerPoint slides effectively in their presentations, and possessed sufficient skill to examine and download various web pages and photographs from the Internet to supplement their presentations. The participants were all also able to type at a reasonable speed. It was heartening to see that, despite being deprived of extra opportunities to practise their skills because of being denied access to the computer rooms outside of scheduled lecture times, the students were sufficiently enthusiastic to make use of Internet cafés that their own expense. Some also had access to personal computers (but no access to the Internet) in their homes.

Organisational dimension

The organisational dimension showed that the pre-service teachers were skilled at working in groups (a *sine qua non* in any constructivist classroom). The pre-service teachers worked cooperatively together to complete all the necessary activities. Their respect for one another in their teams enabled them to work well together as groups.

Their discussions were fruitful, intelligent and effective. They were able to elect group leaders without any difficulty, and were able to negotiate the respective tasks that would be performed by each member of each group. It is also noteworthy that all the members of each group were allocated roles in the presentations.

4.4 The challenges of using computers in a constructivist instructional approach

After they had completed their constructivist learning event, each of the pre-service teachers was subjected to a short interview by the researcher. These interviews gave the researcher further opportunities to reflect on how well each student had been able to perform in the learning event as well as on the challenges that students faced when they were required to use computers for constructivist instructional purposes. Firstly, all the pre-service teachers agreed that the constructivist learning event had served as a good introduction to the ways in which teachers can utilise their computer skills to enhance both teaching and learning. Although they were not consciously aware that they were using a specific instructional approach that had been selected by the researcher, they agreed that the topic had been well chosen and that it was relevant to their lives because it was something that they could not ignore and they had often heard discussions about malaria on television and radio.

The pre-service teachers were happy with the way in which they'd been given their instructions, and they mentioned that they understood what had been required of them without any further assistance from the researcher or their ICT teachers. It emerged that the greatest challenge that all the pre-service teachers faced during their constructivist learning event was the time constraint. None of them felt that they had been given sufficient time to give of their best. They assured the researcher that if they were required to complete the same kind of task again, they would do much better, but that they would need more time. The challenge of giving students sufficient time to complete their constructive learning tasks is a major challenge in implementing constructivist instructional methods. The researcher has observed that students never seem to have

enough *time* to organise themselves, arrange their activities, search for information, compile and collate their resources, and present their findings.

When the researcher asked the ICT teachers what they felt about the constructivist learning event, they said they were more than happy to see their students making use of the different computer application skills that they had learned in the class (and even of computer skills that were not in the course syllabus). Students who possessed additional computer application skills were observed to share these with others in the class. They also agreed that the constructivist instructional method was good for the students because it helped them to become independent thinkers and workers.

The computer teachers and pre-service teachers emphasized that the students were able to implement various computer applications such as clip art, pictures and animations because of the basic computer skills that they already possessed. They agreed to ask the college's management to allow students to have access to the laboratories so that they have enough time to master different computer application skills as they work on their projects and other class assignments. In order to accomplish this, students need to have *after-hours* access to the computer laboratories outside of a scheduled classroom lectures. Only this will give them sufficient time to experiment and practise both their existing and new computer skills.

The overall impression that I gained about the pre-service teachers' attitudes to group work is that they much prefer to work in groups because the groups give them opportunities to share ideas and resources, to talk to one another, and to give assistance to one another as they complete task activities. When they went to the local Hospital in Lubango, for example, they had selected a group leader to ask the questions while the others were deputed to make notes about the answers that the doctor gave. Back at ISCED, each student presented a segment of the work during the presentations. This ensured that each student would play a part in a presentation. They also intimated that working in groups allowed them to learn new computer skills from one another. Such were the positive experiences engendered by constructivist group work.

Consideration of all the elements involved lead one to assert that the pre-service and ICT teachers all appreciated the potential inherent in using computers in teaching and learning. My conclusion is that constructivist instruction and learning:

- involves learners in active individual and group learning
- liberates the classroom from authoritarian teacher-centred instruction
- frees teachers from the burden of being the artificial centre of all instructional activities
- gives learners opportunities to exercise their personal gifts and talents
- enables learners to benefit from the knowledge, skill and enthusiasm of their peers
- enables learners to realise their unique learning styles and performance abilities
- encourages learners to exercise talents and abilities that would remain dormant in the conventional behaviourist classroom
- gives learners profound but practical experiences of the way that ordinary people perfect skills and acquired new abilities in real life

4.5 Objectivist/behaviourist and constructivist elements in the ICT training of pre-service teachers at ISCED

The results of this study show that the teaching and learning processes observed at ISCED reveal both constructivist and behaviourist characteristics and tendencies. Data gathered in the project confirms that behaviourism is the predominant mode of instruction at ISCED ─ in other words, the kind of instructional processes and attitudes that one may observe in all traditional classrooms. This kind of teaching prevails in most schools and teacher training colleges. While the ICT teachers who participated in the study were not consciously aware of constructivist teaching methods, they also used collaborative learning and projects as one of their instructional methods. This is an accepted constructivist means of teaching. They were therefore combining constructivist and behaviourist elements in their teaching.

In the following sections I will discuss the results from the questionnaires and interviews that reflect how constructivism and behaviourism complement one another in Cronjé's Four Quadrant Model (2000) shown in figure 4.6.

The implication of Cronjé's (2000) Model is that the two polarities of behaviourism and constructivism complement one another as learning theories. One polarity or quadrant describes the objectivist/behaviourist approach which assumes that reality exists as an essentialist dimension outside minds of students and teachers. The corollary of this assumption is that personal skill and mastery in education must be acquired from behavioural mastery of the tasks that need to be performed (which in the case of this study are computer application skills).

In contrast to this, the constructivist approach is based on the assumption that no external, independent, essentialist reality exists in itself in a world "out there", but that all reality is the product of interpretations made by human minds. If this philosophical position is accepted, behavioural mastery in the form of transferring knowledge or skills from the mind of the teacher to the mind of a passive learner cannot be tenable position. The constructivist position is that every learner is well equipped to create his or her own personal meanings and reality by tackling authentic learning tasks in the social setting of the constructivist classroom. Constructivist teaching and learning is therefore based on the recognition that students should be given opportunities to demonstrate their skills, talents and abilities by solving authentic learning tasks by means of discovery, exploration and cooperation with other learners in a non-directive classroom environment. Collaboration, exploration, cooperation and active personal engagement are therefore the hallmarks of the constructivist method.

4.5.1 The ICT teachers

Information gathered from the questionnaires completed by the two ICT teachers reveal that their teaching methods are more behaviourist than constructivist. The questionnaires were administered to both ICT teachers before the commencement of the constructivist learning event. Each teacher completed his questionnaire individually. My aim in doing

this was to test and if possible confirm by means of triangulation the information that the pre-service teachers had given me about the teaching and learning methods used to teach the Computers in Education course at ISCED.

The main teaching method that the ICT teachers use to teach the Computers for Education course at ISCED is the lecture method. The teachers supplement their lectures by asking the pre-service teachers occasional questions. What most of the time, however, the ICT teachers dominate their classrooms in the traditional teacher-centric behaviourist way. They also used short-answer questions and multiple-choice questions for assessment purposes. They occasionally also set essay-type questions that the students had to complete. This kind of teaching method corresponds to traditional teacher-centred teaching processes.

In their responses to one of the questions in the questionnaire (which asked if their use of computers in teaching had effected any kind of change in their teaching methods), both ICT teachers agreed that having to use computers in instruction had indeed changed both their teaching objectives and their methods. Because they were using computers in their instruction, they now also included more learning applications than they did when they were merely lecturing. They now set mini-projects for the students for which they need to type their own documents, find and insert appropriate clip art, and incorporate additional relevant information from the Internet. Requiring the pre-service teachers to participate in learning by using different computer application skills represents a move towards constructivist learning and learner-centeredness.

The teaching of computer application skills at ISCED (as explained by the ICT teachers themselves) mainly involves the teaching of the basic skills of Microsoft Word, Excel, and PowerPoint. The students are also taught how to search for information on the Internet. Both teachers said that they are usually set practical activities for students so that they would be able to acquire some of the skills they needed. In this way they gave the pre-service teachers opportunities to put into practice what they had learned in theory.

The ICT teachers said they always organised their students into groups for practical work. They required them to work in pairs so that they could help one another. Sometimes, however, they were required to work individually. The use of group work as well as giving learners opportunities to discuss their tasks so that they might learn from one another is one of the characteristics of constructivist teaching. It is my opinion that the ICT teachers are unconsciously using a considered combination of instructional processes to teach the Computers for Education course.

If one uses Cronjé's (2000) Model to describe their teaching style, the ICT teachers seem to fit most accurately into the instruction quadrant in which the dominant teaching style is supplemented by the use of tutorials, lectures, tasks of various descriptions, and techniques of drill and practice. While the teaching at ISCED is mainly dominated by lectures, the teachers also incorporate drill and various forms of practice and assessment rather than authentic learning tasks. The ICT teachers do, however, use projects for their teaching and expect the pre-service teachers to work both collaboratively in groups as well as on their own from time to time.

The teaching style of the two ICT teachers is therefore more behaviourist than constructivist (these complimentary teaching style quadrants are depicted in figure 4.6 below)

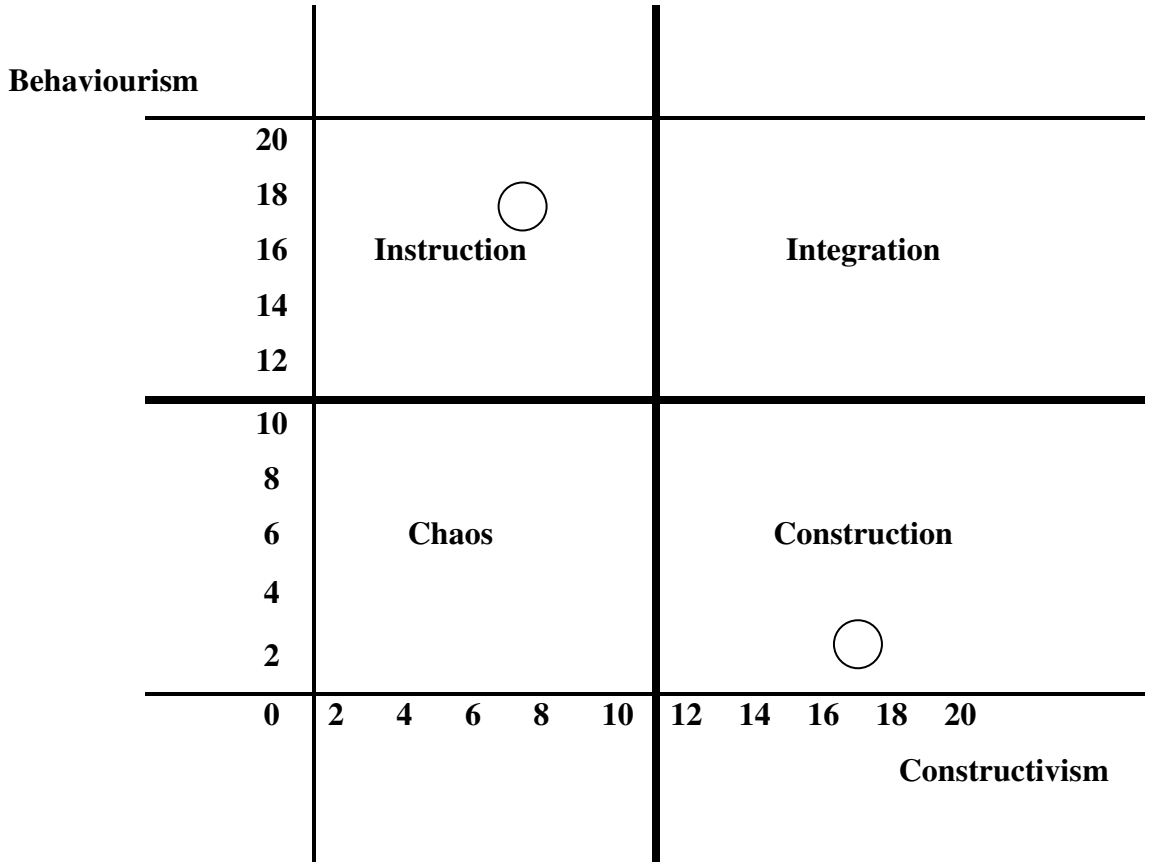


Figure 4.6: Objectivism complementary to constructivism. The four quadrants of teaching and learning. Adapted from Cronjé (2000).

In the interviews, the ICT teachers revealed somewhat different views about teaching and learning theories and practices. The interviews were of course conducted *after* the pre-service teachers had completed their constructivist learning event. The aim of this interview was to obtain the views of the teachers about the effect of the constructivist learning event on the pre-service teachers and the possible implementation of constructivist techniques in the future teaching of their course.

The data shows that their first impression of the learning event was that the topic was most suitable and relevant to the needs and interests of people living in Angola. One of

the teachers, however, was hesitant about fully supporting the use of authentic tasks of a constructivist kind such as the one used in the research study. His opinion was that the selection of the topics and the method chosen to teach them should depend on the particular objectives of the tuition being offered on a specific day. He said:

> "The selection of activities depend on the objectives. As to computing, mainly in our department, our main concern had to do with the learning of computer basic skills and application of the programs."

The argument here was that traditional behaviourist methods are best suited to achieving the objectives of the syllabus as defined by the university's curriculum. When the ICT teachers were asked if they thought that constructivist learning events were at all relevant in any way to the instruction of the pre-service teachers, they replied that the learning events of this kind were indeed relevant because the pre-service teachers had managed to complete the task with few questions and hardly any assistance (once the purpose and requirements of the learning task had been outlined to them).

The main positive outcome of the learning event, in their opinion, was the ability of the pre-service teachers to apply their computer application skills in new and unexpected ways. This had surprised them. The pre-service teachers had, for example, used clip art, searched for, scrutinised and downloaded immediately relevant information from the Internet, used pictures from Internet sites, and even made copies of information they had found on first-class websites such as that of the World Health Organisations. They had also successfully conducted their own interviews at the local hospital in Lubango, typed, collated and formatted their documents, prepared their slide and their commentaries, and then presented their findings by making effective use of the PowerPoint facility. These forms of instruction had never before been used in teaching the Computers for Education course at ISCED.

Before the pre-service teachers began to work on the constructivist learning event, they divided themselves into six groups. I also asked the ICT teachers about their overall

impressions of the group activities as the pre-service teachers worked on the learning events before the presentation stage. One of the teachers responded by saying:

> "I think that group work is good because it gives the students room to work on their own with no direct pressure from the teacher. I liked the way they worked in groups and the way they organised themselves in their group work."

> "As they work together in groups, they learn from each other by sharing ideas [and] information, and [they] also teach themselves computer skills."

The ability of the pre-service teachers to work effectively in groups was one of the successes of the constructivist learning event. The pre-service teachers worked extremely well and showed no signs of conflict or disagreement within the groups. They also managed to complete the tasks in hand and present their work with confidence and assurance. It is my opinion that the pre-service teachers worked particularly well in groups because the groups gave them an opportunity to demonstrate how much they knew and what they could do by themselves (something that one does not encounter to any significant extent in authoritarian teacher-centric classrooms).

The ICT teachers showed themselves to be deeply appreciative of all aspects of the constructivist learning event. They were enthusiastic about each component of the learning event: the pedagogical component (which includes the relevance of the topic to the pre-service teachers), the technological component (that included demonstrations of different computer application skills), and the organisational component (in which the students showed how effectively they could organise themselves and work together in groups without continuous teacher interference in the process). The ICT teachers agreed that they themselves would like to implement this kind of instruction in the future teaching of their course.

The outcomes of the constructive learning event may be described in terms of the constructivist quadrant in Cronjé's (2000) Model. The constructivist quadrant accurately

describes the way in which the pre-service teachers were allowed to construct their own meaning in the learning event, the way in which they worked together collaboratively in groups, their creative application of dialogue and discussion as a means of discovery and problem-solution, and the way in which the researcher and the ICT teachers were only present to provide support and facilitation should the need arise. As a result of the interviews, my own view is that the learning event issued in circumstances and behaviour that were decidedly more constructivist than behaviourist.

4.5.2 Pre-service teachers

The focus group interviews of the pre-service teachers at ISCED indicated that the constructivist learning event was a success and they could also use this type of instructional design in their future classroom instruction. I conduct of the focus group interviews for the pre-service teachers after the constructivist learning event. My purpose in doing this was to obtain the teachers' opinions about the pre-service teachers, the constructivist learning event and the research in general before it had been completed and performed. I also wanted to obtain their views about the feasibility of using constructivist methods of teaching the computer course in their own classrooms in the future.

The focus groups interviews indicated that they were happy to have participated in the research study because the experiment had introduced them to a new style of instruction that they had not been informed about in their teacher training courses. When they were asked if they had found the constructivist learning event relevant to themselves, the groups said the topic was relevant because malaria is an illness that constitutes an prime health risk in their own communities. The need to work on this topic and conduct original research right up to the level of the hospital medical superintendent, provided them with new information, insights and ideas.

> "This learning event was relevant because we worked on a topic that affects all of us (malaria), and as we do not have enough information about it, we got an opportunity and we went to the field, especially the hospital where we learnt more about malaria."

The use of authentic tasks and the selection of topics that are relevant to local people and communities are especially important in constructivist learning events. Local examples tend to engage the interest and commitment of learners more readily than the topics for removed from their day-to-day reality.

> "The learning event made learning easier for us since we could go out and do research and then share information in the classroom [that] we think that this is quite relevant to us."

The learning event was structured by guidelines that the researcher had carefully prepared and that the pre-service teachers had to follow if they hope to complete the task satisfactorily. During the course of the interviews, the participants said the guidelines were an important component of the learning event because without them, they would not have been able to perform tasks required by the learning event. The students in the sample were much more accustomed to conventional behaviourist modes of instruction in which teachers explain everything to them. They had never previously been given an educational task for the solution of which they were completely responsible. Initially they seemed to have no clue about what they should do, but as they began to examine the guidelines, they set to work with increasing confidence and assurance. It was not long before they were all working quickly and effectively to complete the learning event. The constructivist method assumes that teachers will support their students by giving them very clear, coherent and comprehensive briefs about the authentic, real-world tasks that they expect them to complete. The task itself would have been very carefully selected by the teacher from the syllabus or a specific learning programme teaching, and the teacher would prepared the ground for his or her learners by becoming thoroughly familiar with the topic and all matters relevant to it. After delivering the brief and inviting students to engage with the authentic real-world learning task, the teacher retires from the foreground and leaves the learners to organise themselves to accomplish the component tasks required by the learning event. From the moment when the constructivist task has been made clear to learners, a constructivist teacher becomes an alert observant

background figure who functions as a resource on which learners can call for support, guidance and suggestions *if they need to do so.* The constructivist teacher retains a fine sense of when it is appropriate to offer help and when learners are best left alone to apply their own ingenuity to the solution of their tasks.

The idea that constructivist instruction might be used in their future classrooms was enthusiastically received by all the pre-service teachers who intimated they were keen to use this style of instruction in their own classrooms. They indicated how much they appreciated this kind of instruction because, they said, it gave students opportunities to engage in the practice of learning. They liked the idea of students being given practical tasks to accomplish in the context of the field visits. Self-regulated learning such as that which they had experienced in the learning event gave students the opportunity to carry out their own research rather than merely listen to a teacher droning on in a classroom. They felt that students could learn more outside the classroom. To the researcher this seemed to be an implicit indictment of the quality of much of the classroom teaching to which they had been subjected. The pre-service teachers also noted that the hands-on activities which they require to perform gave them opportunities to apply different computer application skills that they had already learnt about in the classroom (these included the use of clip art, pictures, tables, PowerPoint presentations and animations). Being able to produce an impressive product without active interference from a teacher had increased their confidence in their ability to use computers and computer applications.

What the group interviews also made plain was just how skilled the pre-service teachers were at organising themselves for the purpose of completing the learning task. The efficient internal organisation of the groups enabled the members of each group to share experiences, knowledge and expertise, and to share responsibility for the process, its completion and its presentation before an audience. It is the opinion of the researcher that the success of the groups depended on the ability of each member of a group to make a valuable and active contribution to the end result. Enthusiasm for working in groups was reinforced by the obvious advantages that group work confers. The most obvious

example of how skilled the students were in group work is the way in which they prepared for and undertook a visit to the medical superintendent in the hospital in Lubango. The requirements of the interview necessitated a very careful division of labour: each group together prepared the questions for the doctor; an interviewer was democratically selected by the group itself, and the questions to the doctor were posed by the interviewer while the remaining members of the group recorded both questions and answers. The students showed extraordinary group solidarity in executing these sometimes tricky tasks.

Asking for help or support from teachers and colleagues should form part of most learning processes. When I asked the pre-service teachers whether they ever asked for help while learning computer skills, most of them said that they had asked the ICT teacher on occasions. Others said that they had got help from the staff of the Internet café. On other occasions they sought help in books from the ISCED library. The few learners who depended solely on their teachers for help worked more in accordance with a behaviourist style of teaching and learning. Those who sought extra help from sources other than the teacher tended unconsciously to adopt a more constructivist mode of learning. The interviews show that the learning event was decidedly more constructivist then behaviourist and may thus be categorised in the constructivist quadrant of Cronje's (2000) Model (see figure 4.6).

The results of the questions to the pre-service teachers about pedagogical issues indicated that their ICT teachers used predominantly behaviourist methods of teaching. Twenty pre-service teachers, for example, said that their teachers nearly always used the lecture method for teaching the Computers for Education course. After listening to their teachers for most of the lecture, the teacher would give them an opportunity to ask questions if they had not understood the lesson content. One of the pre-service teachers said:

> "It is not normal for the students to present ideas because the teacher comes into the classroom and teaches, and we have to listen to him. … We do answer questions when the teacher asks us something in relation to what he has taught."

In traditional behaviourist method of teaching, teaching and learning is mostly teacher-centred because students are expected to be the passive recipients of whatever knowledge the teacher offers in the class. This kind of behaviour teaching results in very little active communication between teachers and students.

The teachers of the course carried out assessment mainly by using short-answer or multiple choice questions. These tests are administered at the end of each module. Sometimes the teachers assigned essay-type of questions to the students. Eighteen of the pre-service teachers asserted that they had mostly been given multiple choice questions and occasional essay-type questions. Three of the pre-service teachers said that they had been given multiple choice questions, essays and sometimes projects to complete.

> "Our computer teachers gives us projects to do sometimes, and we have to do these projects in groups and sometimes individually. Projects are good because they give us opportunity to share ideas with others."

The ICT teachers supplemented their use of short-answer question tests with the occasional project. The opportunity to engage in projects was greatly appreciated by the pre-service teachers because they gave him opportunities to share ideas and also to work in groups (an activity in which they were clearly skilled). Group work enabled students to engage in discussion, dialogue and the negotiation of tasks and group positions as they worked collaboratively on projects. The sharing of experience, knowledge and ideas are one of outstanding characteristics of constructivist learning.

Though the ICT teachers used mainly teacher-centred mode of teaching, they did occasionally ask questions and they expressed their appreciation for what students knew by supporting correct answers and correcting wrong answers. All the pre-service teachers said they knew that their ICT teachers supported their attempts to learn, and they understood that these teachers were attempting to reinforce correct learning by asking questions, by setting essays, and by assigning project work.

The teaching and learning processes do not end with active teaching. The way they worked together in classrooms and outside of classrooms constitute a large component of teaching and learning. Collaborative work in groups and individually is one of the most important criteria for the constructivist classroom. The idea of social learning emphasised by Vygotsky enables learners to share information and experiences, to discuss and explore new knowledge in the company of their fellow learners, and to improve morale by creating a unity of purpose in the teaching and learning enterprise. Fourteen of the pre-service teachers said that they preferred to work in groups, while seven of them said they preferred to work individually because group work can become problematic when some members of the group are lazy and contribute less then others, and finally when some members of the group just sit back and expect others to complete the work. Although group work may be problematic, good planning, sensitive observation and careful arrangement of the composition of groups can result in an equitable division of labour that makes group work more effective than solitary individual engagement.

The decision whether or not to use group work in classrooms as a method of teaching and learning will depend on the way in which teachers want their students to learn. In behaviourist teaching, for example, learning is highly individualized and fuelled by competition among individuals. In constructivist teaching, by contrast, learning takes place mostly in groups. When group work is functioning really well, there is no competition among group members, and mutual respect between members in the group replaces dominance behaviour, competitive advantages and demoralising comparisons between members of groups. At ISCED, for example, the ICT teachers use group work in a minor way to complement the predominant lecture method. The teachers at ISCED also undertook responsibility for selecting members of the groups. The answers of fifteen pre-service teachers to questions in the questionnaire confirmed that it was their ICT teachers who always selected group members. Five of the pre-service teachers said they would prefer to select their own members because they knew each other as friends and presumably also had a clearer idea of the capabilities of potential members of the group than did their teachers. This kind of strategy for selecting group members can give

rise to problems because some students (for whatever reason are less popular than others. Perhaps such students are known to be low achievers. Perhaps they have few friends among the groups. In any event, self-selection of group members is not without potential problems, and teachers should always take responsibility for preventing less talented or less popular students from being ostracised by groups because they are unwanted, unappreciated or even disliked.

My final assessment as the researcher of the responses to the learners' interviews and questionnaires was that the ICT teachers tended mainly to use a behaviourist mode of teaching supplemented in a minor way by some constructivist elements. The consequent allocation of this kind of teaching in Cronjé's (2000) Model of the Four Quadrants may be seen in figure 4.6.

4.6 Summary

The teaching and learning processes at ISCED are predominantly behaviourist and teacher-centred because ICT teachers use the teacher-centred lecture method for their teaching while conducting assessment by means of multiple choice questions, occasional essays, and even more occasional projects. These are the means that the computer teachers use to conduct formative assessment and summative assessment. The use of projects, group work and occasionally expressed verbal appreciation (feedback) by teachers of learners' performances supplements to a minor extent the dominant behaviourist style of teaching at ISCED. Teaching at ISCED may be said, in conclusion, to be predominantly behaviourist even as it is supplemented in a minor way by a few constructivist methods of instruction.

Chapter 5

Conclusion and Recommendations

5.1 Introduction

Behaviourism and constructivism are two learning theories that have historically exerted the most influence on teaching and learning processes in the West and in countries that have adopted Western models. Although learning theories are basically philosophical constructs, they exert a very real influence on all practical manifestations of education delivery because they define the foundational ideas and premises upon which practical instruction is based. Education takes place in accordance with the practices and approaches recommended by a particular theory of learning (or, in some cases, more than one theory of learning). One may say that a learning theory functions as a manifesto that describes in a concentrated and quintessential manner the foundational values and approaches of particular learning theories such as behaviourism and constructivism. By implication, it also describes the ideal format that a particular kind of learning theory will produce. It also outlines the kind of attitudes and behaviour to which teachers and learners are expected to conform in the physical setting of the instructional arena. The attitudes and behaviour of teachers and learners in a strongly behaviourist setting should be noticeably different from the attitudes and behaviours of teachers and learners in a constructivist classroom. The differences between educational learning theories is therefore more than a matter of purely philosophical interest and concern. The different assumptions and recommendations of radically divergent learning theories such as behaviourism and constructivism produced teaching and learning experiences that are profoundly dissimilar in content, aim, atmosphere and results.

One might change the metaphor and assert that learning theories are maps that enable us to navigate purposefully through our educational enterprises. Such philosophical maps enable us to arrive safely at our destination and to understand whatever conditions that we encounter on the way. They provide us with a means for understanding the constantly changing phenomena of teaching and learning processes, and they define for us the

landmarks that assure us that we are on the right course. According to Cronjé, (2000) these two dominant learning theories, objectivism or behaviourism, and constructivism, reside at the two polar extremes of a philosophical continuum. Cronje locates the objectivist or behaviourist approach on one side of this continuum. This is an approach which assumes an existing reality outside of the students and which advocates behavioural mastery learning as a method to train students towards getting to know that reality. At the other polarity of the continuum Cronjé locates the constructivist approach. This philosophical paradigm asserts that reality cannot be correctly described in terms of essentialist exterior conditions, but that learners acquire the education they need by constructing their own meanings during social interaction with other learners while attempting to solve authentic educational tasks and problems. The constructivist paradigm attributes great importance to the individuality of the learner as well as to the unique capacity that each learner has to use his or her own skills and talents in the acquisition of learning.

Although the learning theories that Cronjé locates on his quadrant may be as radically dissimilar as constructivism and behaviourism are, he points out that one may pursue one's educational objectives by selecting particular aspects or elements from the different learning theories represented in each of the four quadrants of teaching and learning (Cronjé, 2000). Cronjé labels the four quadrants as representing instruction, integration, construction and chaos. In this study I undertook to investigate how well a selected sample of pre-service teachers at ISCED were being prepared to integrate computers with practical classroom teaching by means of the course Computers for Education that is currently offered at ISCED. Two questions were asked namely: What specific type of teaching and learning process is being used by the ICT teachers to prepare these pre-service teachers? In what quadrant could one place their teaching and learning processes? My own research in this investigation was firmly based on a constructivist learning event that I specifically designed for the students sample from ISCED.

Constructivism is a theory based on observation and scientific reflection on how human beings learn best. It asserts that "people construct their own understanding and

knowledge of the world through experiencing things and reflecting on those experiences" (Hein, 1991, online). Constructivism supports a learner-centred process of instruction because it proposes that "learning environments should support multiple perspectives or interpretations of reality, knowledge construction, context-rich, experience-based activities" (Jonassen, 1991, p. 10-11). Educationists who use a constructivist approach to instruction need to have a very clear understanding of exactly how learners create meaning so that they can create the correct conditions for promoting learning in terms of the constructivist paradigm (Jonassen *et al.*, 1995, p.17).

Schools that are based on a behaviourist model regard learners as empty vessels that need to be coercively filled with educational knowledge or blank slates (tabula rasa) on which academic knowledge, skills and character development need to be forcibly written by instructors and teachers. Gover and Gavenk (1995) observe that behaviourist classrooms are heavily teacher-oriented because the teacher is always central to the learning process and because teachers in such settings are required to serve as intellectual and moral role models for students. Teachers in behaviourist formats keep a strict control over the physical and mental activities of students. They also decide exactly what students should learn and evaluate the progress and achievement of students from their test results and from their academic achievements.

The data generated by this study was analysed on the basis of Cronjé's (2000) Model that locates the four quadrants of teaching and learning on a square grid according to their inherent characteristics. More specifically, the data was illuminated by Cronje's model as an exercise in objectivism and constructivism (which are complementary to one another in the model). I used Cronje's model of the four quadrants of teaching and learning in the hope of obtaining conceptual clarity about the teaching and learning processes undertaken by the ICT teachers at ISCED. What emerged from the data when it was analysed in this way was that the teaching and learning processes were predominantly behaviourist in kind and could therefore be categorised by invoking only one extremity of the continuum that Cronje uses as the basis of his taxonomy of teaching and learning types. Cronjé (2000) suggests that the optimal point for teaching and learning resides in

the integration quadrant because it is there that the most advantageous combination of instruction and construction appears in appropriate conditions. The integration quadrant may in fact be described as combining the best features of behaviourism and constructivism. It is precisely this combination or integration that is necessary if optimal outcomes are to be achieved in teaching and learning. The data generated by this research study indicates that that this particular teaching and learning process at ISCED was emphatically behaviourist in kind, and that behaviourism dominated the teaching and learning processes. In contrast to this, the design and application of the learning event in the study transformed the predominantly behaviourist style of teaching and learning to which students were accustomed at ISCED into one that was distinctly constructivist in nature (although certain behaviourist elements continued to feature as part of the learning event).

5.2 Summary

5.2.1 Conclusions about the pre-service teachers

Since the teaching and learning methods used at ISCED were predominantly teacher-centred, it seemed to me inevitable that they should exert a corresponding effect on the way in which students were taught to integrate teaching and learning processes with computer application skills at ISCED. The pre-service teachers' views about the manner in which they were being taught in the Computers for Education course confirmed my intuition that the teaching style used in the course affected the way in which students perceived the kind of teaching role that they themselves would more or less inevitably adopt in their future classroom situations. Although one may make the assumption that the pre-service teachers had elected to study at ISCED so that they might learn how to integrate computers effectively with their future teaching methods, the kind of instruction that they received at ISCED signally failed to equip them with the kind of knowledge and expertise that they would require once they had graduated. Inquiry revealed that the teaching and learning methods employed at ISCED consisted mainly of lectures that permitted little if any room for discussion and dialogue, and that the assessment techniques used by instructors included multiple-choice question formats, questions in

which students were required to insert information into blank spaces, and essay-type questions. What Hanson-Smith (1997), as quoted by Batane, (2004), wrote about his study is exactly applicable to the pre-service teachers in my own research. He wrote that: "because of the poor preparations of pre-service teachers on how to integrate computers in their teaching and learning process, and [because of a lack of] appropriate support and direction, […] working with computers has become a passive activity with little constructive learning" (Hanson-Smith, 1997).

The futility of making working with computers in classrooms a teacher-centred activity is emphasised by Stepich (1996). Stepich notes that the current introduction of technology in classrooms has removed teachers from their position as the (literal) centre of attention in the instructive milieu while simultaneously abolishing their roles as dispensers of necessary information. Teachers in classrooms in which computers are central to the teaching and learning process are now instead required to play the part of facilitators who determine project goals and who provide guidelines and resources. As teachers move from student to student and from group to group in this kind of context, they might hint at (rather than impose) solutions, and offer suggestions, inspiration and specific or general support to students as they engage in the solution of authentic learning tasks more or less independently of immediate teacher influence. The essential feature of constructive learning is that the learner rather than the teacher becomes the centre of the processes of teaching and learning.

It should be noted that the teaching and learning processes at ISCED incorporated certain amount of group work. The pre-service teachers who constituted my sample were required to undertake projects as one of the elements of the course. Such projects gave pre-service teachers opportunities to demonstrate their talents and uniqueness in social skills and team work. Although dialogue and negotiation were seldom used as instructional techniques by the teachers of the Computers in Education course, pre-service teachers were nevertheless required to negotiate solutions among themselves to any difficulties that might arise during project work, and to finalise among themselves both the stages as well as the final form of each individual project.

5.2.2 Implications of an instructional approach – constructivist pedagogy

One of the positive implications of the learning event was that it permitted an effective use of constructivist teaching and learning strategies. Thus, for example, the pre-service teachers were able to make use of whatever knowledge of malaria they already possessed. This made it easier for them to prepare coherent and logical presentations of the subtopics that they were required to deal with on the topic of malaria: these included the cause of malaria, its symptoms, the ways in which the disease is transmitted, how it may be prevented, and modern treatments and cures.

The design of the learning event gave the pre-service teachers in the sample the option of using different resources to collect data. They could, for example, conduct Internet searches to find useful and relevant websites. One such website is that of the World Health Organisation (WHO 2004). This site contains the latest information about how malaria specifically affects people in Angola. Most of the pre-service teachers demonstrated various computer application skills and varying degrees of efficiency as they made use of different computer programs. Most of them were able to navigate commonly used computer programs such as Microsoft Word and Microsoft PowerPoint without any assistance. All the pre-service teachers in the sample without exception gave evidence of good social skills and an ability to perform as part of a team. Both these aptitudes are necessary capacities for successful constructivist learning. In Fosnot's (1996) research into technology, in this case the author emphasises that students can learn effectively on their own if they are given the necessary equipment and conditions. In practice this means that if teachers allow their students to engage in constructivist learning, they will be surprised to see how readily learners adapt to new learning strategies and how learning styles of this kind provide learners with authentic learning experiences. The richness, intensity and variety of constructivist learning processes have long been suggested by proponents of constructivist theory.

5.2.3 Challenges inherent in computer use

The data from this study indicates that what most hindered the pre-service teachers in the constructivist learning event was that they had never learned anything about the

respective learning theories on which different teaching and learning styles are predicated. In particular, they were hampered by their ignorance of constructivist learning theory. It was thus difficult for them precisely to identify the learning requirements of the learners who were their clients. According to Stepich (1996), the main challenges are "how to incorporate computers successfully into the school curriculum and maximize its benefits to education" (Stepich, 1996). This suggests that familiarity with constructivist learning theory as well as instruction in how to use computers effectively in classroom pedagogy should be indispensable parts of the undergraduate curriculum for student teachers, particularly in teacher training colleges where pre-service teachers have first-hand opportunities to use computers in both teaching and learning.

Poole and Moran (1998) suggest that it is limited and inadequate staff development that prevents teachers from using existing technology in their teaching. Various studies have shown that pre-service teachers are in fact inadequately prepared to use instructional technology and that they are unable therefore effectively to integrate technology into their school curriculum (Beaver, 1990; Brooks & Kopp, 1989; Roblyer, 1994). A survey of 1,100 Michigan pre-service teachers indicated that 90% both wanted and needed more experience in the use of computers (Berger, Carlson & Novak, 1989). Pre-service teachers will only acquire the necessary experience and expertise in the use of computers in pedagogy if they are well trained in the theory of learning and in practice, and if they are allowed to have access to computers so they can practise computer application skills to the extent that they desire.

5.3 Conclusion

The results of this study enable one to deduce that although the teaching process to which the pre-service teachers were subjected at ISCED was more behaviourist or instructional than constructivist, the ICT teachers concerned unconsciously implemented constructivist teaching methods. Some research studies provide a justification for supporting an approach that "integrates and provides students not simply with a single instructional computer course, but also with methods and elective courses that integrate and model computer use throughout the program" (Todd, 1993; Wetzel, 1993). Schacter (2001)

reports that institutions that provide routine opportunities for using computers in everyday classrooms and practical experiences report the highest level of student computer skills *even in their future schools*, while Harel and Papert (1991) note that "skills and processes are best learned when they are not taught in isolation, but are acquired within the context of accomplishing meaningful tasks" [my italics]. An inevitable conclusion would be that pre-service teachers should be encouraged to use relevant complementary teaching theories as the basis of their practice as they aspire to achieve all of their teaching goals in the context of classroom practice.

5.4 Recommendations

The results of this study indicate that the curriculum of the Computers in Education course at ISCED needs to be revisited. What this means in practice is that the pre-service teachers at ISCED who follow this course need to be adequately prepared to use computers effectively in their future classroom practice. Adequate preparation in this context implies that each pre-service teacher should have a clear understanding of why the constructivist method of teaching and learning is the only truly efficient and suitable practical and theoretical basis for computer-based classroom pedagogy. What the pre-service teachers in my sample most urgently needed was specific instruction about how they might apply learner-centred (constructivist) instructional methods in computer-based teaching.

My recommendation to policy makers in Angola is therefore that the Ministry of Education (together with the institutions responsible for curriculum development) be asked to revise the curriculum so that students receive adequate theoretical and practical instruction in the kind of constructivist teaching and learning methods that are necessary for effective computer-based education. This instruction will include an overview of learning theories relevant to computer-based education, an appreciation of the difference between teacher-centred and learner-centred pedagogy, and an understanding of the part that authentic problem-solving tasks and social (team) skills play in constructivist learning. Prospective teachers from ISCED need to be familiarised with the difference between the teacher-centred classroom and a classroom in which learners are expected

and encouraged to engage in authentic problem-solving learning tasks either alone or in groups. Teachers also need to be given information, practical advice and tuition in the kind of assessment techniques that are used in constructivist tuition. These include projects, portfolios, and presentations of various kinds, peer-assessment, group assessment, teacher-assessment and self-assessment.

Less tangibly, but no less importantly, prospective teachers need to understand and make a clear commitment to the unique atmosphere of a constructivist-style classroom ─ so different in every way from the old-fashioned behaviourist-style classroom in which values such as unquestioning obedience, conformity, passivity, dependency, hierarchy and purposive lack of originality predominated. Further implications of a constructivist method of teaching are discussed in greater detail in various places in this text.

Because hierarchical and authoritarian methods of instruction have for so long been normative in education, constructivist pedagogy might indeed strike many serving and prospective teachers (especially those who were trained in pre-computer modes of pedagogy) as novel, disruptive and even revolutionary. My central thesis and recommendation is that computer-based classroom education can never be truly effective *except on the basis of constructivist instructional methods*.

Since the investment on the part of the government in computer technology for education must necessarily be a continuing one, it is essential that teachers be properly equipped to make optimal use of the computers that they will inevitably encounter in increasing numbers in educational contexts. Since both computer technology and teacher training represent expensive investments on the part of any government, it is necessary to ensure that such investments are not made in vain.

A recommendation for future study is that research needs to be undertaken to establish what exactly a more integrative type of learning would be in the kind of context described in the study. There is an urgent need, for example, for an intervention in the form of a short course that would introduce pre-service teachers such as those at ISCED

to different learning theories so that they would have the necessary theoretical understanding and practical expertise to prepare their own daily constructivist learning events. The ability of prospective teachers to integrate computers into their classroom teaching might then be assessed by using the kind of learning event that formed the basis of this study.

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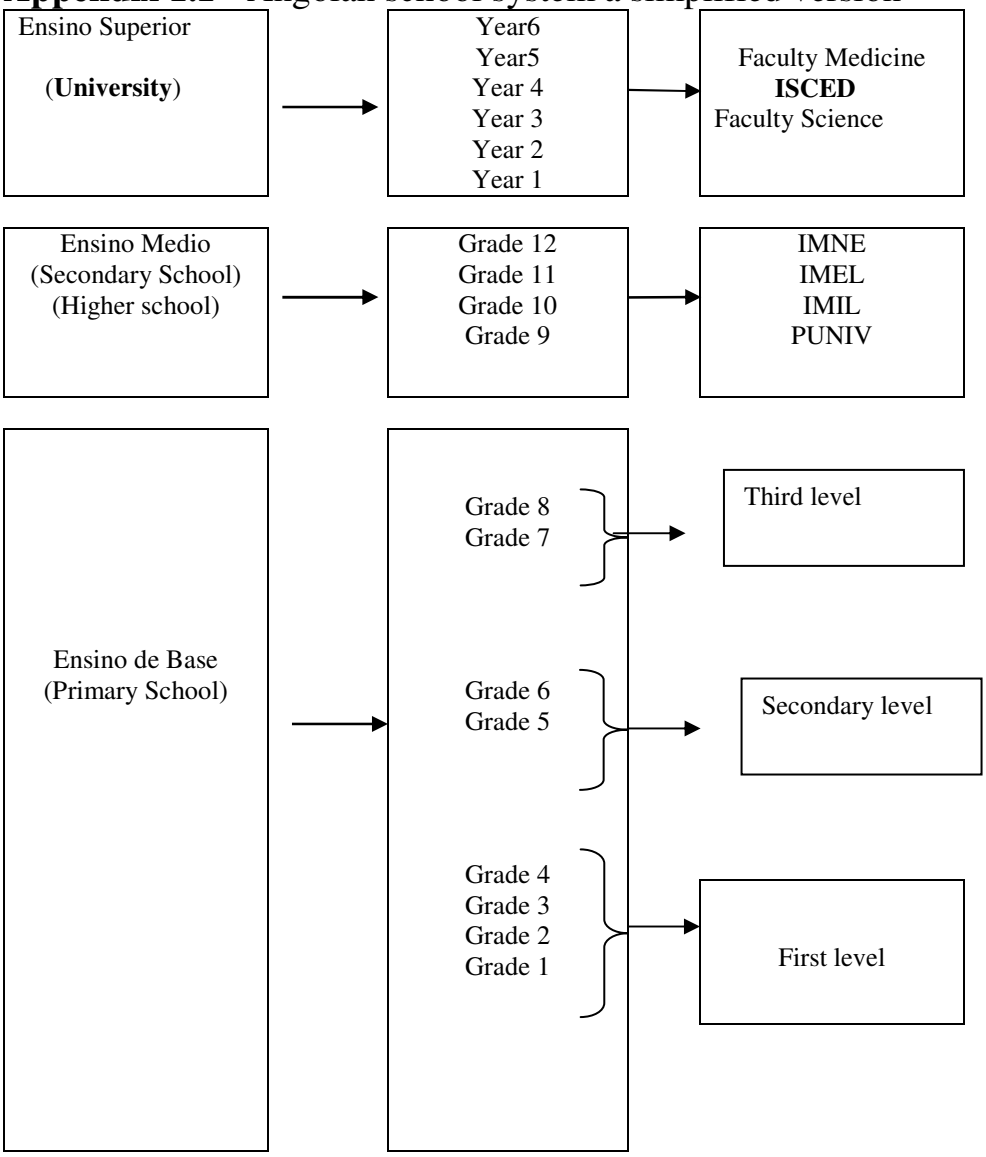
Appendix 1.1 - Angolan school system a simplified version



Appendix 3.1 - Questionnaires for ICT teachers and pre-service teachers– English version

Questionnaires about the use of computers at ISED ICT Teacher

Institution:	
Gender:	
Age:	

The questionnaire is divided into three sections namely: pedagogical, technical and organizational dimensions. Please answer all the questions to the best of your knowledge.

Pedagogical dimensions

1. How do you assess your learner's tasks? E.g. do you give them written tests with multiple choice questions, or you assess the tasks using their presentations and writing skills.

2. Have the objectives you use changed in any way?

3. What differences have you noticed in the outcomes for your students following the use of computers? What made you to choose the use of computers in your class instead of using a lecture method?

Technical

1. How do you use computers for classroom purposes?

2. What are the advantages of using Internet in your class activities?

3. How does the use of computer in your classroom assists in achieving the objectives you set for your students?

Organizational:

1. What instructions do you have to consider when planning for use of computers use in your classroom?

2. What classroom organizational must be considered with the addition of computers to your classroom?

Your time in answering the questionnaire is much appreciated

Thank You!

Questionnaire about the use of computers at ISCED - Pre-Service Teachers

The questionnaire is divided into three sections namely: pedagogical, technical and organizational dimension. Please answer all the questions to the best of your knowledge. You are welcome to write your views.

Institution:	
Gender:	
Age:	
Degree/ Course:	

Pedagogical
1. How your teacher does assess you? Projects, essay type, tests it is multiple-choice questions…if others explains.
2. During classroom situation does the teacher promote discussions or questions and answers? Explain. What made you choose this course? Justify. Does the teacher allow students to present different ideas to get the solution of the task given? Explain
3. Does the teacher appreciate the work of the students? Explain. Have you learned any theories in your course? E.g. constructivism, cooperative learning, behaviorism, individual learning, etc.

Technical
1. Do you have computer at home? Connected to internet? Do you have access to the Internet at ISCED? Or do you have to go to an Internet café? How do you use computers? For e.g. typing, preparation of lessons…please explains.

2. What are the basic programs you can use? E.g. Microsoft word, excel, power point. Are the software programs at ISCED relevant to you? Please explain.
3. Where did you learn to use computers? Where do you go for support, or ideas for computer use? Do you always ask your friends or do you get help from your teacher? Explain

Organizational
1. Do you prefer working in a group or individually? Please state reasons for your answer.
2. And who selects the members of the group you or the teacher?
3. And the teacher assists you? In which way he does it? Explain.

Your time in answering the questionnaire is much appreciated
Thank You

Questionnaire for ICT teachers and pre-service students-Portuguese version

Questionario acerca do uso de computadores no ISED

Instituicao:	
Sexo:	
Idade:	

O questionario esta divido em tres partes denominadas: Dimensao Pedagogica, Dimensao Tecnica, Dimensao Organizacional. Por favor agradeco a sua resposta a todas as questoes que apresento:

Dimensao pedagogica

1. De que forma avalia dos teus estudantes ? Ex: Sao avaliados por inter-médio de testes escritos de multipla escolha, perguntas longas ou desenvolvimento,trabalhos de grupo e quando fazem estes ?…por favor exlpique.

_____

_____

_____

_____

2. Que diferenca notou nos resultados dos seus estudantes quando comecaram a utilizar os computadores ? Explique.Teve algum impacto positivo

_____

_____

_____

_____

3. Os objectivos tracados durante o ano mudaram muito desde que comecou a utilizar os computadores na sala de aulas? Explique.

Dimensao tecnica

1. Que tipo de aplicacoes em informatica exige aos seus estudantes para o uso dos computadores na sua disciplina? Explique..

2. Pensa que depois dos estudantes terem participado na minha recolha de dados aprenderam algo mais ? Ou alguma coisa mudou no decorrer de suas alulas ?Explique por favor.

3. Que sistema de apoio oferece aos seus estudantes ex: voce selecciona websites para os alunos ou podem fazer a sua propria investigacao?

.

Dimensao organizacional:

1. Qual a sua opiniao sobre thabalho de grupo?

2. Acha que valeu a pena o trabalho apresentado aos estudates durante a minha recolha de dados? Explique por favor, oqe gostou e o que nao gostou?

Agradecemos pelo seu tempo ao responder o questionario

Questionario aos estudantes acerca do uso dos computadores no ISCED

O questionario esta dividido em tres partes nomeadamente: dimensao pedagogica, dimensao tecnica, dimensao organizacional. Por favor responda inteligentemente todas as perguntas solicitadas, deve escrever o seu ponto de vista qiuando solicitado. Estas questoes sao na sua maioria relacionadas com o professor de informatica.

Instituicao:	
Sexo:	
Idade:	
Formacao:	

Pedagogico
1.Como o teu professor avalia os vossos conhecimentos? Manda por exemplo: fazer projectos individuais ou colectivos, faz testes escritos (quando?) com perguntas de multipla escolha, longas, ou de desenvolvimento, trabalhos de investigacao? Explique por favor.
2.Durante as aulas o professor orienta os estudantes de forma a que estes consigam liderar um tema em descussao, ou seja deixa que os estudantes exprimam as suas proprias ideias acerca do tema proposto? Explique .
3. O professor da algun insentivo aos estudantes que normalmente se destacam na sala apresentando boas ideias, respostas? E o que faz para os estudantes que se apresentam com mais dificuldades?

Tecnico

1. Como e que utilize o computador? Por exemplo para investigar se tem internet, or para praticar, de justificacao para esta questao.

2. O que o/a fez escolher esta formacao computadores para educacao?

3 Ja ouviu falar sobre algumas teorias de educacao? Por exemplo construtiva, tradicional. De exemplos. Ja ouvio falar de alguns teoristas , como Bruner, Skinner…De exemplos

Organizacao

1. Prefere trabalho em grupo ou individual? Substencia a sua resposta.

2. Quem selecciona os membros do grupo os estudantes ou o professor? Quais sao os criterios na escolha?

3. O professor apoia os estudantes no decorrer das actividades? De que forma?_____

_____

_

Obrigado pela sua colaboracao

Appendix 3.2 – Interviews for ICT teachers and pre-service students

Interview for the ICT teacher

Pedagogical

1. Is the selection of the activity presented to the students by the researcher relevant to you? Justify.

2. Are the instructions provided to pre-service teachers by the researcher relevant?

3. What differences have you noticed in the outcomes for your students following the use of computers and from the different learning theories? Will you use this way of teaching in future? Yes /No/Why?

Organizational

1. As a teacher what is your overall impression of the group activity?

2. What do you think about collaborative work? Do you think that this way of preparation is easy for the students to learn?

3. What do you think worked well during the preparation and or presentation of the students? What did you dislike?

Technical

1. What do you think about computer applications?

2. What computer skills have the students learned?

Focus group Interview questions - Pre-service teachers

Pedagogical
1. Is the selection of the activity used relevant to you? Justify
2. Are the guidelines provided relevant? Justify
3. Will you use this way of teaching in future? Yes /No/Why?

Technical
1. What did you learn in the use of computers and its applications?
2. Do you think that this way of preparation is easy for you to learn effectively?
3. What computer skills have you gained from this activity?

Organizational
1. What do you think worked really well during the preparation and preparation of the tasks?
2. What did you enjoy most during this time? What did you dislike?
3. Where do you go for support, or ideas for computer use? Do you always ask your friends or do you get help from your teacher? Explain.

Your time in answering the questionnaire is much appreciated
Thank You!

Interviews for teachers and learners Portuguese version

Interview for the ICT teacher

Pedagogical

1. A seleccao das actividades é relevante para si?

2. As instrucoes fornecidas aos novos professors sao relevantes para estes executarem a actividade?

3. Que diferencas notou nos resultados para os seus estudantes apos o uso de computadoes? Irà utilizar este tipo de ensinono futuro?Sim/Nao/Porquê?

Technical

1. O que pensa sobre o uso dos computadores na vida pratica?

2..Em sua opiniao acha que os estudants aprenderam um pouco mais neste trabalho, no que toca a aplicacao dos conhecimentos que estes adquiriram?

Organizacional

1. Como professor, qual a impressao total das actividades em grupo?

2. O que acha sobre trabalho colaborado? O que nao gostou?

3. Acha que com esta forma de preparacao é mais facil para os estudantes aprenderem efectivamente? O que acha que funcionou bem durante a preparacao e ou apresentacao dos estudantes?

Focus group Interview questions - Pre-service teachers.

Pedagogico
A seleccao das actividades a serem utilizadas sao relevantes para si?
Qual é a relevancia das diretrizes atribuidas?
Irà usar este tipo de ensino no futuro?Sim/Nao/Porque

Tecnico
O que aprendeu durante o uso dos computadores e das suas aplicacoes?
Acha que com este tipo de preparacao é facil aprender com mas eficacia?
Que novas tecnicas ganhou apos estas actividades?

Organizacional
Qual a impressao que tem sobre as actividades em grupo?
O que acha sobre trabalho colaborado?
O que acha que funciona bem durante a preparacao e na preparacao das tarefas?
O que gostou mais durante esta altura? De que nao gostou?
Se tivermos que refazer este trabalho, o que acha que demos retificar?

Appendix 3.3 – Observation checklist

Observation checklist -Pre- Service Teachers

The checklist is used to check the use of computers as the pre- service teacher's prepare their activities and during the presentations was a Holistic 3-Point scale of 1-3 meaning:

1- Power	**2- Good**	**3- Very good**

Pedagogical

Description	**1**	**2**	**3**
Can the learner work on provided tasks? Did the learner manage to find own resources and collect data?			
Did the learner use emails/ hard copies to distribute information?			

Did the learner ask for assistance or guidance? And from whom? The researcher or peer?			
Did the learner make his/her own planning?			

Technical

Description	1	2	3
Does the presentation run without problems? The information presented is well organized? Do the students know how to insert e.g. pictures, colour work with slides, etc?			
Can the learner integrate different programs in one presentation?			
Can the learner use the keyboard and mouse effectively?			
Can the learner use internet –to search for information, or emailing?			

Organizational

Description	1	2	3
Did the learners work collaboratively in groups or individually?			
Did they share the resources provided?			
Did they discuss with each other?			
Did they negotiate and come to consensus during their preparations?			

Your time in answering the questionnaire is much appreciated
Thank You!

Observation checklist - Pre- Service Teachers.

The checklist is used to check the use of computers as the pre- service teacher's prepare their activities and during the presentations.

1- Mal	2- Bom	3- Muito Bom

Technical

Descricao	1	2	3
Existe problemas com o decorrer da apresentacao?			
O aluno sabe inserir fotografias no computador?			
O aluno pode integrar programs diferentes nas apresentacoes?			
O mouse e o teclado sao dominados pelos estudantes?			
O aluno pode acessar a internet? Email, etc.			

Pedagogico

Description	1	2	3
Os alunos podem trabalhar em tarefas atribuidas?			
O aluno conseguiu encontrar os seus proprios recursos e recolher informacao?			
Como é que o aluno fez a distribuicao de informacao?			
Os alunos pediram assistencia ou guia? De quem? Dos experts ou colegas?			
Os alunos fizeram os seus proprios guias?			

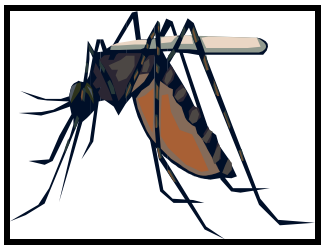
Organizacional

Descricao	1	2	3
Os estudantes colaborarao ou trabalharao individualmente?			
Dividirao os recursos atribuidos?			
Conversarao entre colegas?			
Negociarao e chegaram a um consenso durante as suas preparacoes?			

Appendix 3.4 – Constructivist learning event for pre-service teachers

Activity on (problem solving) constructivist learning (intervention) activity

Introduction



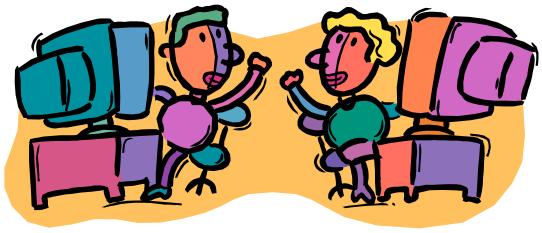
Malaria is one of the illnesses most common in some of the African countries. Angola is one of those most affected where many people die. Lubango is of the cities in Angola where the people are more affected. This motivated the researcher to focus on this issue involving people in Lubango.

Context: the cooperative learning task about causes and prevention of malaria in Lubango (Angola).

Activity: When you are done with this task you will know the:

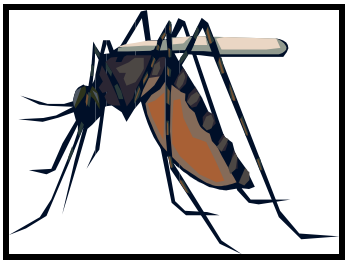
- Causes of malaria
- Spread of malaria
- Prevention/ treatment of malaria
- People most affected by malaria
- Age group affected
- Suggestions about what can be done

Process: Go and find information from the hospital in Lubango or in the clinics or others institutions to collect data about malaria.
List all the thinks and steps you will need in this activity and slide show to presents your work in group.



Assessment: the learners in the class will evaluate the work of others groups according to the results.. This can be peer assessment because learners can evaluate each others work.

Introducao:



A malaria é evidente nos paises Africanos, Angola concerteza nao escapou e o Lubango em particular uma das cidades onde o indice de doentes continua elevado.

Muita gente morre todos os dias nos hospitais, clinicas, em casa, etc, por causa desta doenca.

Como voce é membro desta comunidade educacional, dê sua contribuicao no sentido de educar a populacao acerca da prevensao e tratamento da malaria. Que conselho dara a esta camada e o que fara para aderirem ao seu apelo.

Procedimentos

Trabalhe em grupo de 3 ou 4 colegas e procure informacoes acerca da malaria em Angola e Lubango em particular.

Investigar:

Causas da malaria, na comunidade, qual é o grupo mais afectado entre criancas, adolescentes, jovens, velhos, mulheres gravidas e adultos

Informacao/ pratica

Use toda informacao possivel ao seu alcance exemplo: livros, biblioteca, jornais, internet, etc.

Va ate as clinicas e hospitais seleccionados, procure pela informacao nao esquecendo de fazer um pequeno questionario as pessoas que estao directamente involvidas.

Compilação / Processo:

Troque informações na sala de aulas com os colegas pode ser via internet ou informação escrita, ou outra via.

Faça finalmente um pequeno resumo sobre estes dados ja processados e prepare uma apresentação em PowerPont para todos nos isto e seus colegas, e professores.

Avaliação:

Todos podem participar nas avaliações.

Muito obrigada pela vossa colaboração.

Appendix 4.1- Rubric used for to assess the observation process as learners worked on the constructivist activity – pedagogical dimension

Categories		Level of criteria	
Pedagogical dimension	**1- Poor**	**2- Good**	**3-Very good**
Previous knowledge of the pre-service teachers about malaria.	- Preparation of the task, it shows that the pre-service teachers had poor basic knowledge about the topic of malaria. - Bad structure of the work and a lot of information was mixed up.	- Preparation of the task shows good application of knowledge about the topic of malaria. - The structure of the work and the content was well-written.	- Preparation of the task shows very good application of knowledge about the topic of malaria. - The structure of the work was well documented and the ideas were clear and well-written.
Use of variety of resources	-The students made use of information from internet.	-The students made use of information from internet, the hospital experts, and local newspapers.	-The students made use of information from internet WHO (2004), from experts of the hospital, local newspapers and the library of the faculty.
Support during preparation, presentation of the task	-The pre-service teachers were ashamed to ask for help, or did not look for guidance.	-The pre-service teachers did ask for help and guidance from the teacher or the researcher in order to help them with the instructions.	-The pre-service teachers did ask for help and guidance of the teacher or the researcher, this means they could understand well the instructions given to them at the beginning of the research study.
Way of planning activity or task given for the learning event	-Difficult to understand their way of organization in the group: - They did not set time - they did nor select their group leader.	-They were organized and read the papers given to them. - Organized themselves to do the activity - Set the time for them to complete the task - They were all committed to do the task	-They were well organized. They read the activity given to them. -They discussed what to do in their groups - They planned what each one has to do. - They selected one of the group members to lead the group by asking questions to the Dr in the hospital. - They committed themselves on how to

			go about doing and finishing the work on the time stated

Prepared by Ilda kussumua Jan/ 28/2006

Appendix 4.2 - Rubric used for to assess the observation process as learners worked on the constructivist activity – technical dimension

Categories		Level of criteria	
Technical dimension	**1- Poor**	**2- Good**	**3- Very- good**
-The presentation of the program (slide show presentation)	-The presentation was not so good very few slides were done.	-The presentation was good, some slides were done and run well using the button	-The presentation had almost 11 slides running well, display from on to another using arrows and the enter button
fficient use of programs (PowerPoint, insert pictures, animation)	-They needed assistance to use the program – use of bold, paragraph, insert picture, table background. -During presentation they had no animation	-They did not need assistance to use PowerPoint presentation program. - Good use of paragraphs, insert pictures, statistical table, from the hospital. - During presentation they had use of animation.	-They did not need assistance to use the program –good use paragraph, clipart, add tables of the statistics from the hospital. -During presentation they had proper use of animation, rearrange slides, and modify slides.
Manipulation of keyboard and mouse	-In general they had problems in using mouse and keyboard and poor typing speed. - During the presentation the slides were presented not using the slide show but used the mouse but with assistance	They manage to use properly the mouse and the keyboard but did not have good typing speed. - During the presentation the slides were presented not using the slide show but used the mouse	-They manage to use properly the mouse and the keyboard had good typing speed. - During the presentation slides were presented using slide show by clicking using the down and up keys on keyboard without any assistance.
Internet surfing and e-mail	-Internet surfing skills were not good. Not knowing how to get immediately what they wanted to get in	-Their surfing skills were good, but did not have an extra picture about mosquito	-They had good internet surfing skills because – they added an extra picture about mosquito

	terms of information. -Managed to get only the text information about the task and nothing more.	transmission from the internet into the text, but managed to give extra examples of malaria affected countries. - Application skills, for example they searched for information from internet.	transmission from the internet into the text, and gave extra examples of malaria and affected countries. - Applications skills, for example they searched very well for information from internet they could include the dates of the search, and sites were they searched for the information.

Prepared by Ilda kussumua Jan/ 28/2006

Appendix 4.3 - Rubric used for to assess the observation process as learners worked on the constructivist activity – organizational dimension

Categories	**Level of criteria**		
Organizational dimension	**1- Poor**	**2- Good**	**3- Very Good**
Cooperative or individual work	-After the introduction of the task everybody worked individually. - When going to the hospital to collect data they went individually. - Did not organized questions to be asked in the hospital. - The presentation was done by one student from the group but he was not selected in the beginning as the leader of the group	-After the introduction of the task they selected a leader. -When going to the hospital to collect data they went together. - Organized some questions to be asked in the hospital. - The presentation was not done by all members of the group	-After the introduction of the task one acted as a leader to others after they had selected him. - When going to the hospital to collect data they were all involved in what they had to do. - Organized a small questionnaire to ask the people evolved on the malaria. - The presentation was done by all the participants equally in the group.
Peers discussing and dialogue	-There is a little talk and exchange of information after being introduced to	-There minimum talking and exchange of information after being introduced to	-There was enough talking and exchange of information after being introduced to

	the task. - There is no communication between themselves when they were in hospital. - During the presentation there was no talking to each other.	the task. - There is minimum communication when they were in hospital. - During the presentation there was minimum talking to each other. talking to each other and in one of this group only one student presented all the work	the task to all. - There was good communication between the participants when they were in hospital and before that, because all involvements was necessary to get the solution of the task - During the presentation there was equal talking to each other and each one presented equally.
Presentation the activity (delivery of the task?)	-Presenting activities in the group was done only by one student - One of the students organized some questions to ask the Dr in the hospital - One student presented all the work	-Presenting activities in the group was done only by the leader of the group however involved others. - The leader of the group organized the some questions to ask the Dr in the hospital, others assisted in compiling the questions. - The big part of the presentation was done by the leader and others did the smaller part.	-Presenting activities in the group was done by all the students each with the responsibility to do something - The leader of the group involved others in organizing some questions to ask the Dr in the hospital. - The presentation was done by all the participants equally in the group.
Division of labour	-No leadership figure to divide the activities in group. - One of the group members took notes in the hospital while others just stood and waited. - One student presented all the	-There is leadership figure to divide the activities in group. -The leader organized the group and one of the members took notes in the hospital. - The bigger part was presented by the leader, and others	There was no direct leadership figure as everyone was involved equally. - All the members in the group organized themselves and took notes in the hospital, which were then shared in the discussion later.

	work	presented the smaller part.	- All the members presented equally.

Prepared by Ilda kussumua Jan/ 28/2006

Appendix 4.4: Rubrics used to assess pre-service teachers power point slides (task documents)

Categories	**Level of criteria**		
Pedagogical dimension	**1-Poor**	**2- Good**	**3- Very Good**
Knowledge and understanding of the topic about malaria.	The pre-service teachers demonstrate some knowledge of the topic with less clarity about malaria in the World, Africa, and Angola- Lubango	The pre-service teachers demonstrate quite bite of knowledge of the topic with clarity about malaria in the World, Africa, and Angola- Lubango.	The pre-service teachers demonstrate extensive knowledge of the topic with depth and clarity about malaria in the World, Africa, and Angola- Lubango.
Evidence on clarity topic of malaria	Pre-service teachers did not give examples in other countries.	Pre-service teachers give some examples of other countries.	Pre-service teacher give good examples of other countries and explanations were provided.
Creativity and effort	Pre-service teachers did not use the pictures to show malaria parasite or others picture in connection to the topic given to them.	Pre-service teachers used appropriate pictures of malaria parasite or others picture in connection to the topic given to them.	Pre-service teachers used the appropriate pictures, charts to show malaria parasite and other pictures in connection to the topic given to them.

Prepared by Ilda kussumua Jan/ 28/2006

Appendix 4.5 Letters :

- Request to the research
- Letter from Dean of ISCED

Angola
Huila-Lubango
Dear
Matondo Tomalela

Pretoria
10/03/2006

Dean of the Faculty of Education

Request to the research

I am a Masters student doing Computer Assisted for Education at University of Pretoria as you could see on my email that I send to you the last two weeks. My research is about the importance of the learning theories and specifically the learning event in constructivism learning. For that the use of computer is crucial, therefore I would like to do this study using the students for the computer course.

I would like to say that this will happen from 18 /06/ 2005 to 30 August.
I will be very grateful if you kindly organize with the teacher and the coordinator of the course in order to have the students informed and have their voluntary participation.

Thanks so much for your attention and collaboration
Kussumua, Ilda

UNIVERSIDADE AGOSTINHO NETO
INSTITUTO SUPERIOR DE CIÊNCIAS DA EDUCAÇÃO
ISCED/LUBANGO

GABINETE DO DECANO

Prof Johannes Cronjé
University of Pretoria
Faculty of Education
Groenkloof Campus
Leyds Street
Groenkloof

2 September 2005

Dear Prof Cronjé

Research: Mrs Ilda Kussumua

It is hereby confirmed that Mrs Ilda Kussumua, your Master student in Computer-Integrated Education, has conducted her research at ISCED-Lubango on the implications of computer training of pre-service teachers from Friday 25 August to Friday 02 September 2005.

Should you need further information, please do not hesitate to contact us.

Yours Sincerely,

Matondo Tomalela, PhD
(Dean)