CHAPTER 2

ROLES AND FUNCTIONS OF COMPUTERS IN THE LEARNING ENVIRONMENT

2.1 Introduction.

This chapter is devoted to a review of relevant literature on the roles and functions of computers in the learning environment in developed and developing countries. In this chapter, I investigated through literature search the use and integration of computers in teaching and learning. It constituted an appropriate and reasonable framework for the discussion of relevant issues. This exercise also revealed what is currently being done and what has not yet been accomplished in this field. The purpose of the literature review was to identify the main lessons from previous research that are relevant to Kenya, and to use this for more detailed exploration of specific topics in my case studies in Nyanza Province. It also provided an insight into the methods, measures, subjects and approaches used by other researchers that I could use to design and formulate my field research tools. The review of literature also provided information on the potential benefits and limitations of computers and their effectiveness in teaching and learning. The literature review covers six major areas adopting the classification of Heinich, Molenda, Russell and Smaldino (2002:214), and Anderson (1991). They listed the main roles and uses of computer application in the classroom in America and developing countries. This included: the computer as an object of instruction; as a tool; as instructional device; as a catalyst; and as a means of teaching logical thinking (Heinich, et al. 2002). In addition, Anderson (1991:40) identified three major modes of how computers could be used in education in developing countries similar to those of Heinich, et al. (2002) and included also the use of the computers as a tutor and tutee. For example, the students for whom the computer is a tutor are able to work through tutorial type programmes at their own time or pace. The computer as a tutee facilitates communication between students and a teacher in distance learning program via the Internet or e-mail (Heinich et al. 2002).

The objectives of this review of literature were concerned mainly with describing various ways in which computers have been used in secondary education. This

included reviewing previous research findings and related literature on the functions of computers in secondary education, the use of computers in teaching and learning computer literacy skills. It also examined literature on the use of computers in teaching and learning traditional secondary school subjects such as mathematics, sciences, social studies, languages and graphics. In addition, the chapter discusses the teaching strategies, the role of the teacher in classroom instruction, relevance of CIE in schools, impact of computers on students and teachers are examined. Further discussion looked into the roles of computers in teaching and learning; benefits and limitations of computers; and relevance of CIE in teaching and learning. The review of literature also examines government policies that guide the integration and use of computers in schools.

2.2. Government policies on the use of computers in schools

The introduction of computers in the school environment in many countries came about as a result of government policy pronouncement (Clark, 2000; Crawford, 2000; Kirkman 2000; Mizukoshi, Kim and Lee 2001 and Pearson, 2001). Most of the policy statements were written documents and others were not documented for circulation to schools but were contained in the existing educational policies. Since then computer technology has flourished in almost all sectors of education. However, in teaching and learning, the computer is used to enhance educational potential, and is now widely used as a teaching and learning tool. However, the integration of computers into teaching and learning is a critical issue that requires adequate support from the government. In order to successfully integrate computers into teaching and learning, there is need for a clear government policy to guide schools in their implementation programs. Pearson (2001:279-290) reports on various government policies on the use of computers and noted that the American government formulated computer policy in 1996 titled "Getting America's students ready for the 21st century." The policy document included the provision of technology and during the last decade, the number of microcomputers in schools was in the ratio of 1 computer to each 10 students. Other reports indicated that most states in USA required teachers to be computer literate. For example, "Title 5 Regulation, in Section 441617 of the California Education Code (California State Legislature1997), requires teachers to take an educational computing course." (Zhao and Cziko, 2001:6).

Similarly in Australia Pearson (2001) reports on the government policy document on the use of computers that was entitled "Learning Technologies in Victorian schools." The government was committed to improving teaching and learning through the use of appropriate computer technology and computers are available in schools to the students' ratio of 1 computer to each 12 students. Russell et al. (2000:158) adds that the policy recognized the importance of teacher education in computer technology. For example, one of the State Education Departments (Education Queensland) developed the "Minimum Standards Project (Education Queensland, 1999) for teachers in using IT." The standard requirement included four key areas: "information technology, curriculum planning including classroom planning and management, school planning and student-centred learning." The other requirement was that "all teachers were to have a minimum level of skills in the use of computers for learning." In addition, the Australian Council for Computer Education (ACCE) 2000 developed a rationale for the specification of teacher learning technology competencies (TLTC) by teachers. The policy of ACCE suggested that teacher "professional development program should aim at improving teaching practice first and foremost with a goal of improving learning outcome for students" (Russell et al. 2000:158).

Furthermore, Pearson (2000) reports on the British government policy document titled "Connecting the Learning Society: National Grid for Learning" in 1997. In this connection, Opie and Katsu (2000:80) state that since 1980s the British government policy on the use of computers in schools was to ensure that schools were provided with computers and in each school where computers were placed teachers were trained in their use. About 230 million pounds was set aside for ICT training of teachers, and resources were also provided to ensure its successful implementation in UK schools. Opie and Katsu (2000) reported that the Statutory Curricular requirement of the National Curriculum for England and Wales consistently emphasised the incorporation of computers. Even the revised National Curricular that was to be implemented in 2000 stated that "Pupils should be given opportunities to apply and develop their ICT capability through their use of ICT tools to supplement their learning in all subjects." Similarly Crawford (2000:183) reports on a National Curriculum for England introduced in secondary schools in August that contained an order for Computer technology (ICT) that emphasised the teaching of IT as a descret subject. Crawford (2000) observed that the earlier reports in the English National

Curriculum Order for other subjects supported advisory documents. This included policy guidelines such as the School Curriculum and Assessment Authority (SCAA) 1995, National Council for Educational Technology NCET 1995a, NCET 1995b: Department of Education and Employment 1998 continue to stress the value of IT throughout the school curriculum. All these policy guidelines documents on the use of computers in schools demonstrate the commitment of the UK government to IT in schools

Moreover, Pearson (2001:280) describes a five-year Hong Kong government policy document entitled "Information Technology for Learning in a new Era. Five Year Strategy 1998/1999 to 2002/03." Pearson (2001) noted that the policy was formulated because the government was concerned with the adoption and use of computers in schools to widen opportunities for learning, to improve the motivation of learners, and to increase level of students' achievement. Pearson (2001) observed that the five-year policy strategy consisted of various initiatives to promote the use of computers. Pearson (2001) noted that through the government specific policy plan, each secondary school was to get 82 computers, and all schools were to have access to the Internet. Moreover, the policy included teacher-training programs. Schools were to be provided with funds for training teachers in computers so that by 2001 all teachers would have basic skills in computers literacy, and by 2002/3 (75%) of teachers were expected to be competent in the use of computers. The policy also included appointment of computer co-ordinators and some teachers were to be trained in creative work with computers.

In addition, Pearson (2001) reported that the other component of the policy was the provision of resources to teachers. Schools were allowed to obtain extra funds from the government for teacher education programs, and schools were to be assisted by the designated officers from computer resource centres. According to Pearson (2001) most of the policy requirements had been implemented by mid 2001.

Furthermore, to highlight the importance of policy on computers in education Rovisk and Kommune (1995: 856) report that in (1984) the Parliament of Norway approved a white paper no 39 (193/8) which introduced computer technology into schools. Rovisk and Kommune (1995) noted that a ministerial task force was established to

organise and co-ordinate the computer programs. According to their report, the purpose of the task force was to make plans for the introduction of compulsory computer education in schools. According to the scholars, the policy referred to the teacher training, vocational computer training, provision of computers, and by 1987 the government adopted compulsory computer education.

Moreover, from developing countries, Waslowick (2002) reports on Brazilian government Information Communication Technology (ICT) policies and implementation published in 1981. The Ministry of Education and the Secretary of Informatics created the first national ICT project in 1983 to introduce computers in schools. The project was implemented in several centres in different states in order to develop qualified people to deal with computers in education. From 1988 to 1989, the government created more centres for computers in education to produce more trained computer literate people and to create and distribute computers to schools. The Ministry of Education made further development and in 1997, created a new National Programme on computers in education with an aim to distribute computers to schools and to train teachers in computer education. The main objectives of the project as reported by Wazlowick (2002:69) was:

- commit the schools to use computers;
- to install appropriate computers and network facilities;
- to train teachers in computers;
- to produce high quality educational software for use in schools;
- interconnect schools; and
- to provide financial support for ICT project.

According to Wazlowick (2002:69), the project was to be implemented in two phases. The first stage aimed to introduce students and teachers to computers, and in the second stage the computer was to be incorporated in the teaching and learning process and school administration was to be improved with the use of computers.

However, Wazlowick (2002) noted that the government had difficulties in deciding on which schools (among the 7500schools) to receive computers. Consequently, schools

were chosen according to the size of the student population, suitable infrastructures, security, phone lines, and building. As a result, the scholar noted that the Brazilian policy on ICT was to use computers in selected schools only.

UNESCO (2002:30-31) reports of a Malaysian government policy document known as "Education for Smart Schools" that was formulated to develop ICT and was to be implemented in stages. According to UNESCO, the Smart Schools had five main goals that aimed at:

- The development of individual child covering the intellectual, physical, emotional and spiritual domain.
- To provide opportunities for the individual to develop their special strength or abilities;
- To produce a thinking workforce that is technologically literate;
- To democratise education to provide equal access to students to learn with computers; and
- To involve parents of the children, private sectors and the community in ICT education process.

UNESCO noted that the government had a plan to convert all schools to "Smart schools" by the year 2010, and the first phase of implementation began in 1999 as a pilot project in 90 schools. UNSECO observed that the pilot project consisted of preparing computer materials for teaching and learning of four subjects (i.e Bahasa Malaysia, English language, Science and Mathematics). The other component of the project included assessment to give more accurate and comprehensive feedback of students' progress in computer education, and in management system in which computers were to be used to improve school administration required to support the teaching and learning. Furthermore, UNESCO noted that the implementation plan comprised of integrated education with emphasis on thinking, language and values across the curriculum, students to learn at their own pace, teacher to be facilitators of learning rather than pouring all the knowledge and learning being self-directed.

In conclusion, it is important to note that all the government policies discussed above contained common features. All the policies addressed the issue of teacher training in computing skills, provision of adequate computers, teaching and learning resources and financial commitment to the implementation of computer technology in schools. Such computer education policy commitment would be useful for the introduction and use of computers in Kenyan schools. However, this study will explore these policy statements from developed countries to determine if it would be useful for the Ministry of Education in Kenya to publish such written computer policy documents for secondary schools.

The contributions of these scholars indicate that a policy on computers in education is a national responsibility. In this connection, Rudd (2001:212) states that given the current importance of computer education, and the amount of funding involved for computer programs in schools, policy makers in developed and developing countries expect returns from these initiatives in the form of improved standards' of students performance, hence the need for research into the whole school integration and use of computers.

2.3 Functions of Computers in Secondary Education

Computers can play several important functions in the teaching and learning process. Bitter (1989:25) reports that computers are used in education for three major purposes. First they are used to teach students curriculum subjects and computer application tools such as word processor and spreadsheet. Second, computers are used to keep records and to help teachers plan educational programmes. Third, they are used to perform administrative functions such as keeping school records, school budgeting, doing the payroll, scheduling programmes of activities, and keeping students records such as examination results and assessment data as reported by (Becker, 1999; Bitter, 1989; Millar, 1997). The other functions noted by Heinich et al. (1996: 230-232) include that of playing the role of 'an object of instruction'. This applies to the use of computers in teaching computer literacy skills to students in which the students learn about computers, and how to use them for processing and analysing data. This includes teaching students computer programming and other software. The next function according to Heinich et al. (1996:231) is that of the

'computer as a tool.' In its function as a tool, the computer servers as a sophisticated calculator, typewriter, multimedia composer, presentation aid, communication device and data retrieval source. This function can provide students with the opportunities to use word processing for writing and communicating with their colleagues from other parts of the world though e-mail.

Computers can also serve as a tool for classroom instruction as noted by Bitter (1989:232). In this role, students can use computers to solve complex mathematical calculations and to learn how to manage information and create their own databases. It can also help students to learn specific skills in subjects such as mathematics, science, language, social studies and help to increase students' achievement in examinations. Moreover, the computer plays the function of a catalyst for school restructuring. It provides a source of ideas for teachers and can catalyse their development of more varied, more motivating and more contemporary practice. Computers have helped to facilitate the rapid dissemination of new ideas to bring change in the way schooling is organised. This includes introducing alternative approaches to education that revolve around the technology rich environment. Such new changes include students learning in groups, co-operative learning, problem solving, simulated problems and using computer-based tools to collect information. Watson and Tinsley (1996:198) add that computers can also act as a catalyst to equalize experiences between the rich and the poor, urban and rural, and minority and non-minority students. In addition, the computer plays the function of amplification of thinking. That is, teaching logical thinking. The students use, for example, Logo programming that provides them with experiences that enhance their thinking skills.

2.4 The potential of computers as tools of instruction

Computers have several capabilities as tools for classroom instruction. Their main capabilities includes some of the following:

- Computers can store large amounts of information, such as data;
- Computers can also analyse the same data very fast;

- The computer can search information very quickly and provide the results of searches immediately;
- Computers can be made to produce requested information in different ways. This includes, first as text and graphics on television monitor screen; as moving images; as charts, graphs, tables, histograms; second as hard copy through printers and copiers; and third as magnetically-stored information on computer discs, and though cables and telephone links to other computers (Ellington et al 1993:178)
- Computers can control other electronic mechanical equipment, and can be used to access other information storage media, like videodiscs, compact discs and databanks; and
- Computers can be employed to give 'simulations of situations and conditions which would be far too dangerous to work with directly, for example, Processes in the core of nuclear reactors' (Ellington et al. 1993).

These are just a few of the ways in which computers that can be utilized in teaching and learning. However, the ultimate benefits can only be realised if the computer is programmed to perform them in relation to teaching and learning in the classroom.

2.5 Reasons for using computers in classroom instruction

Computers are used in teaching and learning for two main reasons. The first one is that computers can be effective teaching tools across the national curriculum. They can be used to increase the effectiveness of classroom instruction by introducing improved methods of teaching specific skills. The computer is regarded as a very powerful medium that helps students to learn subjects like mathematics, geometry, science, social studies, graphics and other subjects effectively. Secondly, they are used to expand and reinforce students' computer literacy skills. This usage has been viewed as being central to the introduction of computers in developed and developing countries during its inception (Abas, 1995, Boyd-Barret and Eileen 1991, Heinich et al. 1996; Watson and Tinsley, 1996). The computer is, therefore, used to help meet a great variety of educational needs both in schools and out of school education.

2.6 Patterns of using computers in Teaching and Learning

Dexter, Anderson, and Becker (1998) report that computers are used in two identified patterns. First, they are used by teachers to supplement classroom teaching, such as using them in direct relation to curriculum, but they carry only a minor part of the teaching and learning responsibility in comparison to the teacher. This applies to a situation when computers are used as teaching aids in a teacher-centred way. Dexter et al. (1998) add that in this usage, the teacher imparts facts and procedural skills to students and integrates computer technology as a complement to this style. They use computers mainly for drill and practice. Secondly, computers are used as a core part of instruction, carrying out the primary task of teaching, so that the teacher only becomes supplementary. In this way, computers can be used to extend learning opportunities beyond the confinement of the classroom or school. In such use, processes and media resources are given the front line role and they are made an integral part of the teaching and learning processes. This is student-centred learning in which "teachers use software and information technology to allow students to work in active ways. The computer supports active learning, and it becomes a tool with which the students may construct knowledge." However, Addison and Fridman (1997:56) report that such practices are aimed also at reinforcing skills, enriching current topics or extending topics beyond current levels. This includes the integration in which computer technology facilitates learning beyond what is currently possible.

However, in terms of technology integration, Addison and Fridman (1997:56) state that certain barriers and teacher beliefs may lead them to use computers in a supplementary way. Such barriers include limited equipment, lack of teacher training and time, as well as teachers' preferred instructional methods of teaching. But there is a consensus that if all human and administrative barriers are removed, and computers are used in instruction, they could assist teachers to reach their instructional objectives, and teach with increasing effectiveness. Moreover, there is evidence from the literature that computers could be used during private independent study, in a small group discussion and for a large group instruction, to achieve the following educational objectives:

- to provide or increase students motivation,

- to promote learning;
- to increase discussion among groups of learners thereby encouraging full participation;
- to teach skills;
- to improve the effectiveness of other media employed in teaching and learning situations (Addition and Fridman, 1999 and Dexter et al. 1998).

2.7 Benefits of using computers in teaching and learning

Having discussed the roles and the reasons for the introduction and use of computers in education, it is important to look into the contribution they can make as a tool for classroom instruction. This requires examining the disadvantages and advantages to using computer programs to help achieve formal instructional goals. Some of the advantages of using computers are as follows:

- Due to its versatility in handling various kinds of resources the computer is suitable for all types of learning ranging from group learning, individualized instruction, and mass instruction (Ellington and Race, 1993: 220-226).

- Computers involve the students actively in the learning process, and provide fast and systematic feedback to learners (Bitter, 1989: 240-241).

- The computer makes teaching easier for the teacher so it saves time. The teacher can attend to other classroom duties while the students work with computers (Slabbert, 1999:73-74).

- The use of computers offers a change from the teacher's voice and breaks monotony (researcher own idea).

- Computers free the teacher from the daily routine of lesson presentation.

- Computers enable the teacher to help individual students as needs arise during the lesson (Slabbert, 1999: 73-74).

- Computers can give access to rich materials not easily available to the teacher. The computer can bring real-world conditions into the classroom. For

example, with computer simulations students can observe a nuclear reaction or fly jets in the classroom (Bitter, 1989:244).

- Computers give students personalised instruction and students can work at their own pace as they interact with technology. This allows all students, slow and gifted alike to learn at their own pace (Slabbert, 1999:73).

- Computers can be useful for record keeping of students' work. The teacher can keep individual lessons prepared in advanced for all students and can also monitor their progress (researcher own idea).

- Computer programs can provide a broad diversity of learning experiences that embody a variety of instructional methods and can be at the level of remediation or enrichment that is effective for learning (Heinich et al. 1996:234-235).

- The computer is consistent and precise. It supplies reliable and consistent instruction from student to student, regardless of the instructor, time of day or location (Slabbert, 1999: 73-74).

- Computer-based instruction can improve effectiveness and efficiency in teaching and learning. Effectiveness according to Heinich et al. (1996) refers to improved learner achievement, and efficiency means achieving the objectives in less time or at lower cost (Heinich et al. 1996:235).

- Where the teacher is not prepared or does not have other adequate materials, the computer can be the source of information. It can cover a growing knowledge base associated with information explosion and can manage all kinds of information such as graphic, text, audio and video materials (Heinich et al. 1996:235).

- Teachers can use computer programs as a teaching aid to explain or reinforce concepts in many different subjects (researcher own idea).

- Computers can teach students computer literacy as well. By simulating real-life situations, computers can make learning subjects like mathematics, science languages and social sciences interesting and exciting. Because the

instruction can be flexible, it motivates students to learn and enables them to revise what has been learnt (Heinich et al. 2002).

- The computer can provide visual elements in teaching and learning. Colour and animated graphics can add realism and appeal to drill exercises. It is also useful for demonstration and teaching practical subjects topics (Heinich et al. 2002).

- Above all, computers enable students to learn from one another globally through e-mail, and other forms of communication systems.

Although computers can contribute to teaching and learning in many different ways, there are also inherent disadvantages in their use as a medium of classroom instruction. Some of these shortcomings range from administration to the technology itself.

2.8 Disadvantages of computers in teaching and learning

- Hardware and software are still too expensive for most schools to afford, especially in developing countries. Along with this is the cost of maintenance and repairs that in addition may sometimes require the presence of a full time technician to be employed.

- Design and development of software for use with computers requires trained personnel and takes a lot of time. This makes software very expensive to purchase.

- It can encourage lazy teachers not to prepare their work ahead of time. Once they depend entirely on the computer they may not care to plan adequately.

- Computers require a classroom environment free from dust and high humidity, with adequate ventilation and this might not be available in many schools.

- Compatibility is a crucial issue that must be looked into before purchasing the software, because software developed for one computer system may not be compatible with another (Heinich et al. 1996:235). Due to differences in

hardware, computer programs are rarely accessible to many schools and this limits its widespread utilisation (Slabbert, 1999:71).

- Computer programmes usually cover very small sections of the syllabus and do not teach effectively in the affective, motor, and interpersonal skills domains (Heinich et al. 1996:235).

- Commercially designed computer software may not be relevant to the needs of students and teachers. This requires additional time to view and evaluate them, making necessary adjustment before they are used in teaching and learning (Heinich et al. 2002:229).

- There is lack of social interaction among students as they work on the computers alone with little time to consult with one another or with the teacher (researcher own idea).

Despite these various limitations of computers as a teaching aid, the benefits discussed in section 2.4 led many countries to adopt them as tools for classroom instruction. Their potential to provide students with knowledge and practical skills is recognised by many authors and researchers such as (Christmann and Badgett (1999) and Clark (2000). They report that computers are excellent learning device that can be used to aid teachers in teaching various skills and at the same time assist students in learning specific subjects. According to these researchers, using computers for classroom instruction has several possible effects, most of which now require a new approach to exploit the capabilities of the computer as a learning resource in the classroom so that it can be utilised effectively in the learning processes. In this connection, Cornu (1996:5) feels that there is an urgent need for infusing technology into the curriculum and calls for a clear-cut decision with regards to integration of new technologies in schools. Not an addition, but integration in subjects, integration in teaching, integration in learning, integration in the school, and integration in the profession of the teacher.

Before discussing the value of computer integrated education, there is need to define the word to 'integrate' so that all the stakeholders can be clear about its relevance in the effective utilization of computers in teaching and learning.

2.9 Definition of Computer Integrated Education

Oxford Advanced Learner's Dictionary gives two meanings of the word to 'integrate.' The first is 'to combine two things in such a way that one becomes fully a part of the other' and the second refers to 'become or make-become fully a member of a community, rather than remaining in the separate group.' Cornu (1996:3) adds that integration means 'combining parts in a whole.' I believe that the integration of computers into teaching and learning makes both meanings applicable because when the technology is incorporated into curriculum it should be built into the whole education system. Cornu (1996:3-4) looks at the integration of technology in many aspects. First as hardware and software integration, second integration into disciplines, and third integration into teaching and learning. As such, a system of education in any country needs to design integrated resource-based learning in which the new technologies are incorporated to teach specific skills and subject topic areas at the same time. Cornu (1996) believes that only when technologies are integrated will their use become natural, easy and they will have a wide effect on teaching and learning.

Therefore, integrating computers in the school curriculum means introducing a new method of teaching and learning in the classroom which takes into account the following requirements:

- aims of general secondary education;
- meeting new demands of society in students skills;
- reforming the curriculum;
- training teachers in new skills;
- internal school organisation;
- hardware provision and maintenance;
- stabilizing of funding policies;
- support by technical staff;
- equity of access for all students;
- software development and provision;
- development and provision of complementary materials;

- Copyright policies for software (IFIP, 1993:15 in Millar, 1997:6).

Consequently, in order to implement CIE and incorporate computers into the teaching and learning process, the whole school community should be well informed about the new development. This includes teachers' awareness of the demands on their teaching responsibility, students' awareness of changes in patterns of learning, and the need for extra funds to purchase and maintain the computers. Arrangement must also be made to provide the necessary teaching and learning resources and the facilities for integrated learning to take place. This is very important because "technology integration is using computers effectively and efficiently in the general content areas to allow students to learn how to apply computer skills in meaningful ways" (Dockstadder, 1999:73).

Many researchers have also discussed and supported integrating computers into school curriculum (Cornu, 1996; Cameroon, 1999; Heinich, et al.1996; Mills and Ragan, 2000; Sakamato and Miyashita, 1996 and Van Weert, 1996). According to these scholars, an integrated approach has the potential to demonstrate various types of computer applications to teach specific subject topic areas. The teacher could employ software applications as the main classroom instruction or use them as an integral part of the whole school organization. Secondly, when the computer is integrated into the school curriculum, it will be part of the teaching and learning process. This will require curriculum developers to design new integrated curricula and to incorporate technology as a fundamental component of instructional methods. Teachers will also be required to plan their schemes of work and lessons integrating technology. The integration of computers into education should start with the teacher, through teacher education programmes. Thirdly, an integration of computers into the school curriculum will definitely lead to grassroots school involvement. All the school administration, the Parents Teachers Association (PTA), and the Board of Governors (BOG) will take part. This will motivate the teachers and students to find out other ways to utilize the computer technology effectively.

2.10 Teaching and Learning with computers in the classroom

Once the integration of technology into the curriculum is done, teaching and learning changes from the teachers' traditional approach of talk and chalk to a resource-based

approach. Heinich, et al. (1996: 8, and Smith and Ragan (1993: 2) report that teaching simply means giving a person or a student knowledge of something or skill. According to them, teaching is synonymous to instruction. That is, the arrangement of information and environment to facilitate students' attainment of intended specific learning goals (Heinich, et al. 1996:8); Smith and Ragan, 1993:2). This deseription includes the classroom situation, the method and resources required to impart knowledge, skills and to guide students' learning. The teacher as the pilot must plan his/her work thoroughly in advance, and prepare a lesson to include all the necessary motivational skills and activities to present an effective lesson. When the teacher sets to plan the lesson he /she should be guided by some of the following questions:

- What kinds of things does he/she want the students to learn: is it skills, facts, concepts, attitudes or values?
- What are the instructional objectives or desired outcomes?
- What is the most appropriate sequence of topics and tasks?
- What is the most appropriate lesson delivery method?

Since teaching involves what the teacher does as well as what the students' experience, it is essential for the teacher to focus his classroom activities on incorporating the use of computers in a properly structured lesson with clearly stated objectives.

2.10.1 Planning for teaching with computers

How should classroom instruction be organised so that students can learn with computers efficiently? The teacher as the pilot must start by planning how to teach with the technology. This is the logical starting point. Because some schools provide a separate computer education course, and others integrate computers into subject-matter teaching preparation, there is a need to consider how best computer technology could be used effectively. Since the move right now is towards total integration of computers into the school subjects, the teacher must be thoroughly prepared in advance in order to present effective lessons to students in the classroom.

However, the integration of computers into teaching various subjects places a heavy demand on the teacher to be very clear about the statement of objectives. The

objectives will help the teacher to describe the general nature of the curriculum and provide an idea of the amount of work that should be covered within a given period. It will also enable the teacher to consider which teaching methods should be employed. Furthermore, the objectives will assist the teacher to plan the content and process to be used in the assessment (Ellington and Race, 1993).

Moreover, according to Heinich et al. (1996:52) effective teaching starts with careful and thorough planning. Consequently, the incorporation of computers into teaching and learning requires the teacher to have all the relevant skills and resources in order to integrate and use compute effectively. The teacher must have the national syllabus and a course book for the teacher and the one for the students (in the case of Kenya) and other relevant textbooks from which to derive the schemes of work.

2.10.1.1 Preparing the Schemes of work

From my experience, planning the scheme of work is the starting point for effective classroom teaching. A scheme of work is a plan derived from the prescribed syllabus for a particular level of education, showing how much of the syllabus will be covered within a given period, usually one term or two terms. The teacher can exercise his individuality and originality within the limits of the syllabus, in terms of how each topic will be arranged (including the use of computer technology), how it will be taught, how much time will be spent on each topic. But the most important reason for having a teaching scheme is to ensure that the teacher is clear about what he/she wants students to learn. There are also four other reasons for teachers to make a teaching scheme. These are as follows:

- to ensure that the subject matter is covered within the estimated time and that the lessons are taught in the most suitable manner,
- to enable the teacher to cater for needs of the students;
- to ensure continuity in the learning process;
- to enable teachers of different subjects to consult with one another and coordinate their efforts in teaching.

A scheme of work is very important since the teacher extracts the daily lesson topics from it. It is at this stage that the teacher must integrate the use of computers.

Generally, the schemes of work provide a lot of information (content) that the teacher can transfer for planning the lesson and to elaborate on. Such information includes topics, subtopics, teaching aids, references, objectives, students' activities and remarks (Ellington et al. (1993); Heinich et al. 1996 and 2002).

2.10.1.2 Teachers' Preparation for teaching with computer technology

In order to make the best use of computers once the scheme of work is prepared, there are a number of important points to be considered. These include:

- the purpose for using the computer in teaching and learning;
- selecting an appropriate program to integrate into the lesson (Kay et al. 1999:224).
- pre-viewing the program so that the teacher is familiar with the content. This will enable the teacher to make note of any point that can be brought out about the content with the class. The teacher can also edit or modify some irrelevant section of the lesson and replace with better ones from her lesson plan. The teacher can also identify sections that need reinforcement with other visual media to make the lesson more effective, and to ensure that the computer program is up-to-date;
- preparing the students to be ready to benefit from learning with technology. Students could be prepared to use computers in many ways such as: making them aware of why they are using a computer and what they are expected to learn from it, the content could be discussed briefly; and concepts and other unrelated points can be explained.
- Planning for follow-up activities should be carefully organised such that the teacher reinforces what the students have learnt by giving extra assignments or group work.

Therefore, it is important to remember that teaching and learning with computers would be more effective if both the teacher and the learner prepare for it in advance and this can be achieved if the teacher plans carefully and thoroughly.

2.10.1.3 Lesson Planning

From experience, a lesson plan is an important tool that teachers must prepare before proceeding to teach any subject in the classroom. A lesson plan must include: the objective(s), time allocation, steps or stages of the lesson (content to be covered: that is, the information/knowledge to be given to students), teaching aids, in this case the computer, other resources, references, evaluation. These aspects of lesson planning are extremely important in the teaching and leaning process. It should be noted that the lesson plan is the teacher's tool and guide. The teacher is unlikely to succeed in his work in an attempt to incorporate computers in teaching without the aid of a lesson plan.

The value of the lesson plan is that it helps the teacher to focus his attention on the achievement of specific learning objectives. This, in turn, directs the students to acquire or to perform certain behaviour once learning has taken place. In addition, the lesson plan is valuable because it helps the teacher to know in advance his role in guiding the learners as they work with computers, and which activities students are supposed to do if learning is to take place effectively.

There are other important reasons why a lesson plan is necessary for effective teaching with computers. These include the fact that a lesson plan:

- helps the teacher to remember what he is going to teach and how he will teach it;
- is arranged in a systematic way and encourages logical development and presentation of learning materials;
- gives the teacher confidence and assists him in getting his information and ideas across to the students;
- helps the teacher to achieve his objective(s) for the lessons he is expected to teach with technology.

According to Schefller and Logan (1998:305) teaching no longer centres around the transfer of knowledge from the teacher to students. Learning comes from student inquiry, critical thinking, and problem solving based on information accessed from a

variety of sources provided by the teacher. This calls upon the teacher to be a good planner when integrating technology into the lesson plan. A classroom in which computers are integrated into teaching and learning is a place of interactivity. The students work and collaborate as knowledge is applied to authentic situations. The teacher's lesson planning and presentation should aim at providing activities geared towards helping the learner to solve real life problems.

2.10.1.4 Lesson Presentation

Introduction of the lesson: In the introductory part of the lesson, an effective teacher should be able to link the learning that took place previously with the new materials to be learned in the current lesson. He should be able to motivate students and sustain their interest before they start learning with the computers. The introduction to a lesson creates a need in the students to participate fully in the lesson. In addition, it should create an atmosphere that is conducive to the attainment of the objectives of the lesson. A lesson that has been properly planned indicates how the teacher will do this and links the learners effectively to working with computers. The introduction of the lesson should give way and lead into the development of the lesson. The teacher should use the introduction to set the tone for the rest of the lesson.

The main part of lesson: As the students start to work on the computer, the lesson must develop and proceed in a sequence of logical steps or stages that eventually enable the teacher to achieve the objectives and to ensure that learning takes place. During this exercise the teacher's role changes from that of a presenter of information to that of a guide, and he should be able to communicate his ideas by guiding the students on what they are learning clearly by giving clues and cues (Tema, 1998:5; and Heinich et al. 1996:353). An effective teacher should therefore be able to encourage and reward students in addition to motivational effects the students get as they work with computers.

Conclusion or Summary of the Lesson: The conclusion of the lesson offers the teacher a chance to determine whether learning has taken place, and whether the teacher has achieved his objectives. The teacher must plan for effective summary of the whole lesson incorporating students' participation to assess their understanding of

what they have learnt. He can do this by asking questions about the lesson orally or by using written assignments, individual research project or group work.

Organising the Learning Environment: According to Fraser (1996:344) "the classroom environment, climate, atmosphere, tone, ethos or ambience of a classroom is believed to exert a powerful influence on student behaviour, attitudes and achievement." The teachers' personality, manner of dress, cheerfulness and confidence, and disciplinary ability are some of the qualities required of an effective teacher in the classroom. An efficient teacher should therefore be able to organise and manage the learning environment effectively, so that the learners are able to take full advantage of the learning situation, by providing sufficient teaching and learning resources, equipment for students, organising the classroom properly, handling interruptions in a correct manner and maintaining discipline.

During the teaching process the teacher should be able to assess the progress of the lesson and adjust the objectives, if necessary, in the light of experience during instruction and make the necessary comments in the remark column. He should also make changes in other objectives in the light of the emerging knowledge of the learners, their abilities and competencies (Ellington, Percival and Race, 1993:194-7).

2.10.2 Evaluation of the teaching and learning processes

Heinich et al. (2002:74-78) report that "evaluation and revision is an essential component to help the development of quality instruction." Evaluation involves activities that are designed to measure the effectiveness of a teaching and learning system as a whole. There are many purposes for evaluation in education. The two major ones include assessing learners' achievements and evaluating teaching methods and use of media in teaching. Evaluation should be an ongoing exercise in teaching and learning. Teachers need to carry out "evaluation before, during, and after teaching" a topic using computers. Heinich et al. (2002) state that before teaching and learning with computers, the teacher needs to measure learners' characteristics to ensure that there is a fit between existing students' computer literacy skill, the methods and materials to be used. Similarly, during teaching evaluation can take the form of question-answer format or a short quiz to assess if students understand what is taught, and to detect problems or difficulties with instructional method that might

interfere with learners' achievement. But evaluation after the lesson can take the form of a written exercise in which the students work individually with the computers. It can also includes oral work when the teacher assess the general knowledge of a concept from the whole class, practical or group project work on the computer to understand how students perform in a specific subject topic. However, evaluation of teaching and learning need to be planned systematically and discussed by the staff. Evaluation is useful in the effective utilisation of teaching and learning resources.

2.10.3 Appropriate Teaching Strategies

Teachers need to have clear ideas of which methods of teaching could be most appropriate for teaching and at what level to employ such strategies. Teachers have sole responsibility to make decisions of teaching methods they feel confident to adopt with regard to the use of computers. The teacher needs to consider during lesson planning which of the two main teaching approaches in education to use teacher-centred and student-centred approach. Within the two teaching strategies, the teacher can employ any of these methods: Lecturing, use of example, demonstration, discussion, project method, experiment, fieldtrips and discovery. The teaching methods were suggested and recommended by philosophers and psychologists, like Rousseau, Froebel, Pestalozzi, Comenius, Plato, Montessori, Dewey and Piaget (Saettler, 1990:4-7) and many other pioneers in formal education. Their contribution to appropriate teaching method led to the idea of child-centred education. They argued that children must be active in learning and that the idea of pouring information in to them was undesirable. They stated that a suitable learning environment would facilitate the development of imaginative and creative ability in children. Therefore, the teaching methods and the curriculum must be based on the child, and what the child is taught must also coincide with experience through employing different teaching aids in the lesson presentation. Many of their ideas are relevant to the use of computers in teaching and learning, and are practised in schools by teachers to present the lesson. Therefore, the integration of computers into the school curriculum can be effectively realised through these approaches if the teacher is properly organised.

2.10.3.1 Teacher-centred approach

Although the philosophers, psychologists and other pioneers in formal education advocated a student centred approach, many schools and other institutions of higher learning use a teacher-centred strategy (expository). In this approach the teacher imparts to students in the class the subject matter which is laid in the syllabus after preparing the lesson plan. The classes take place according to the school timetable and last for a specified period. The teaching methods vary from teacher to teacher but normally teachers use an integrated approach that combines all the teaching skills such as lecturing, questioning, use of example, reinforcement, stimulus variation and set induction, with lecture as the main method. However, the integration of computers into a teacher-centred approach requires a whole school involvement because the school timetable must indicate the number of periods per subjects to be covered by the computer lessons. In Kenya, this will follow the pattern that was adopted by the former school radio programmes in which all the radio lessons were included in the school timetable. This would serve as a reminder to the subject teachers to infuse the use of computer technology in their own timetable whenever they plan their lesson in a teacher-centred teaching approach.

2.10.3.2 Student-centred Approach

The protest by educators against the curriculum that was teacher-centred led to the adoption of student-centred approaches to teaching and learning. The student-centred (or learner-centred) teaching and learning environment provides students with a high flexibility of choice regarding the learning program that is geared towards the individual student's life and learning styles. It involves the teacher preparing a learning situation with adequate resources for students to manipulate. It also gives power to individual students to access and handle a wide range of information. In this type of learning the students' needs and interest are given high priority, and they are accorded the necessary assistance in order to achieve their learning objectives effectively (Alberts, 2000; Barbara, 1995 and Tema 1998).

The move to student-centred approaches in education is based on the ideas of philosophers and progressive educationists like Dewey (discussed in section 2.9.3) who reported that children would not learn unless their interests are enlisted and

unless learning is self-originated from some instinctual source within them. In addition, Killen (2000:xi) explains that when the teacher uses learner-centred approaches to teaching there is need "to set the learning agenda" such that the teacher has "less direct control over what and how students learn." The teacher is no longer "a provider of all information," but has a major role as a planner, organiser, and a facilitator of learning. Consequently, the infusion of computer technology provides an opportunity for self directed learning in which the student himself plays an active role in the learning process (Alberts, 2000:48). In this learning environment the teachers' role is that of a guide who must prepare in advance what the students are to achieve when studying specific concepts or topics.

The discussion of teacher-centred and student-centred approaches refers to a concern with students learning in the classroom, since instructional and learning activities complement one another in teaching situation. In order to help students to learn effectively, the teacher is expected to create a warm and friendly atmosphere in the classroom that provides opportunities for effective learning to take place. To be able to do this, teachers can employ various educational technologies.

2.10.4 The concept of Learning and CIE

Learning focuses on the individual for whom all instructional activities are designed. Heinich, et al. (1996: 8) describes learning as the development of new knowledge, skills or attitudes when the individual interacts with information and the environment. At the same time, Kozma (1994:8) feels that learning is "an active, constructive, cognitive and social process by which the learner strategically manages available cognitive, physical and social resources to create new knowledge by interacting with information in the environment and integrating it with information already stored in memory." While there are many definitions of learning in different literature, its specification hinges on the following conditions as reported by Heinich et al. (1996), and Ellington, Percival and Race (1993):

- The state of the knowledge of the learner before instruction;
- The statement of the objectives to be achieved;
- How the objectives are to be achieved or exposure to learning experiences;

- Conditions of the learner after exposure in relation to the stated objectives;
- What media is required for the necessary learning experiences? (Heinich et al. (1996 and 2002).

According to Killen (2000:xiii a) "learning is a process of acquiring new information and abilities." Learning takes place any time and all the time. Therefore, the teacher needs to select an appropriate teaching strategy that could provide students opportunity for effective learning. Students' learning is enhanced as they interact with the environment and with the use of various technologies. From a psychological point of view, there are several theories of learning that date back to over half a century, and each has implications for classroom teaching and students' learning with computers (Heinich et al. 1996:15). Students' learning in the classroom can be explained using two major theories of learning namely: behaviourism and constructivism (Alberts, 2000:26-28; Heinich et al. 1996:16-17; Slabbert, 1999:46-48). The more we know about these theories of learning, the concepts and research that underpin them the better we can use computers in teaching and learning. The two theories of learning are important for two reasons explained in Sections 2.9.5.1 and 2.9.5.2.

2.10.4.1 Behaviourist approach to teaching and learning

According to Heinich et al. (1996:15-17), the behaviourist perspective is associated with B. F. Skinner who was the key architecture of the behaviourism movement. Skinner's research with pigeons involved investigating the control and condition affecting stimulus-response mechanisms. Skinner believed that conventional classroom situations did not supply sufficient reward for learning to take place. He also felt that subject matter could be presented to the student in small quantities, and students' understanding should be tested with a written answer before the learner moves to new material. Once the response has been made, the student should learn immediately if the answer was correct or not. In this way, the learner gains psychological reward of success and proceed at his own pace. In relation to the use of technology, Skinner stated that the machine itself does not teach, but simply brings the students into contact with the person who composed the material it presents. The application of Skinner's ideas to learning resulted in the design of linear programs.

Consequently, as result of Skinner's work, Alberts (2000: 26) reports that behaviourism explains learning as a system of behavioural responses to stimuli. He feels that teachers who accept the behaviourist theory assume that the learning behaviour of students is a response to their environment. Because learning is regarded as a form of behaviour modification, the teacher has a duty to prepare an environment in which the correct behaviour of the students is reinforced. He also points out that behaviourists are concerned with the effect of motivation, practice, feedback and reinforcement on learning.

Therefore, in teaching and learning behaviourism for example, places emphasis on writing objectives such as learning objectives, behavioural objectives and performance objectives. At present all teachers in Kenya are expected to write objectives for the lessons they are teaching and all pre-service teachers must learn to write objectives for lessons. Writing objectives is very important because in teaching, teachers need to be very clear about the goals of education to be achieved, and it is not possible for teachers to assess how much a student has learned without defining in observable terms what learning they are seeking. Therefore, from these notions, Tiene and Ingram (2001:26) suggest that teachers must specify the goals of instruction in terms of behavioural objectives that usually consist of three parts. These include: "the behaviour to be learned, the conditions under which the behaviour is to be demonstrated, and the criteria by which to judge the amount of learning."

The significant of the above description of learning is that it provides one model for deciding how to use computers in instruction. Based on the behaviourist approach to learning, computers can be used for mediation of learning, facilitation of learning, collaborative learning, group learning, individual learning and mass instruction.

2.10.4.2 Constructivist approach to teaching and learning

According to Killen (2000:xvii a), the basic premise of constructivisim is that knowledge is obtained and expanded through active construction and reconstruction of theory and practice, and that learning is not just a passive process. Constructivism is described as "an approach to learning in which students are provided the opportunity to construct their own sense of what is being learnt by building internal connections or relationships among the ideas and facts being taught." Furthermore,

this method emphasises that learners actively construct knowledge for themselves by forming their own representations of the materials to be learnt, selecting information they perceive to be relevant, and interpreting this on the basis of their present knowledge and needs. There are two main approaches to constructivism, cognitive constructivism and social constructivism. Killen (2000xiii-xiv a) explains that cognitive constructivism focuses on the cognitive process that people use to make sense of what happens in the world. In the classroom, students use previous knowledge and combine it with what they learn to construct and reconstruct knowledge in order to make it meaningful. On the other hand, social constructivism treats learning as a " social process whereby students acquire knowledge through interaction with the environment instead of merely relying on the teachers lectures."

In this connection, Tiene and Ingram (2001: 34) state that "constructivism has the potential to foster a radically different approach to teaching as well as exciting new uses for computers in the classroom." Teachers can use computers to support constructivist approaches. For example, the computer networks are being used to have students communicate about their learning experiences through e-mail from different places. Students share cultural backgrounds and school experiences in a way that helps them to develop mutual cultural perspectives. Similarly, Tiene and Ingram (2000) add that the Internet has provided a powerful new ways for students to share experiences, opinions, and information with others at vast distances. The scholars believe that computers can provide materials to explore the tools with which to create, and the means with which to communicate. They also feel that these materials can facilitate constructivist efforts in the classroom such that the students explore learning more effectively on their own and the teacher acts only as a guide.

2.10.5 Facilitation of learning via the computer

The other important role of computers in students' learning is that of facilitation of learning. According to Alberts (2000:35) facilitation of learning via technology is concerned with the creation of a supportive learning environment for students to learn effectively with the technology. Such a learning environment should enable personal relationships to be created between the students, the teacher and with other learners. Computer technology has many capable tools that enable the facilitation of learning to take place. For example, the teacher can give the students assignment to work with

word processor to learn communication skills. The students will learn the skills with the computer and at the end of the lesson the students submit their work to the teacher. The computer facilitates learning by giving students instruction on how to perform the task. Researchers have acknowledged the ability of the computer to facilitate learning (Pendretti, Smith, and Woodrow, 1998; Mills and Ragan, 2000). The capabilities of the computer to engage the students in an interactive manner changes the role of the teacher in the classroom from that of a presenter of information to that of a coordinator of learning resources (Heinich et al 1996:353). During classroom instruction, the teacher performs various roles that include being a facilitator, manager, counsellor, a guide, and a motivator. Similarly, in mediation of learning, sometimes the computer is used as a vehicle through which a message can be transmitted to learners for example the use of the Internet or self-instructional programmes.

2.10.6. The Teacher's Role in CIE Learning Environment.

2.10.6.1 How the computers help students to learn

The use of computers as an instructional tool helps students to learn in four over lapping stages. Firstly, the computer **makes students want to learn** by motivating them to become more enthusiastic, and by increasing their interest. Well-designed computer programmes are highly attractive so students can enjoy working with the computers to extract information from databases, or encyclopaedia, and entering information in a word processor. Secondly, the computer enables **students to learn by doing.** The use of computers in teaching is essentially learning by doing, and when the students learn by doing it is far more effective than watching the teacher. When the students learn by doing they become involved in the exercise. They try things out, experiment, practice and learn from mistakes. For example, students use the computer for analysing data in a spreadsheet, and as a communication tool when sending e-mail to different people. Thirdly, the computer can help students to get **immediate feedback** on what they learn. Students are able find out whether what they are doing is right or wrong, good or bad and the computer provides feedback while they still remember the problem. The fourth one is **digesting.** The students have more control over the manner they navigate the materials in the package by moving forward, backward, repeating parts until they get the correct answer or until they understand

the information. The computer allows the learners to gain a sense of ownership over what they learn (Ellington et al 1993:180-181). All of these factors have been shown to be important in helping students to learn in any instructional situation (Killen, 2002).

2.11 The Relevance of CIE to Teaching and Learning

The extent to which computers can be viewed as being relevant in teaching and learning in schools seems to vary from person to person and from country to country. During the early 1980s Clark (1983:445) challenged researchers to refrain from conducting additional studies examining the relation between media and learning. Clark argued that there were no specific learning benefits to be gained from the use of particular media. However, Clark's view that specific media offer no identifiable contribution to learning needs to be reconsidered. For example, a recent review of research literature by Kozma (1991), has suggested that "capabilities of a particular medium, in conjunction with methods that take advantage of these capabilities, interact with and influence the way learners represent and process information and may result in more or different learning when one medium is compared to another for certain learners and tasks" (Kozma, 1991:179). The need for alternative instructional media in teaching and learning has also been reported by Abas (1995). Abas (1995) reported that teachers felt that students learn from computers. Similarly Azita (1999) noted that students learn from computers and suggested a number of particular applications and benefits of computer programmes and recommended programmes that illustrate difficult mathematical calculations. Heinich, et al. (1996) also supported the use of computers in teaching and learning by stating that computers are an integral part of teachers' work and that some students will definitely learn from the use of technology.

From these studies, it would seem that the important question is not " Should computers be used in instruction? But rather "How should computers be used in instruction to maximise student learning?"

2.11.1 Using Computers as a tool in Classroom Instruction

Many claims have been made about the benefits of computers in relation to cost-reduction, and the special advantages as a medium of instruction. But some of these claims have been questioned. Whether the use of computers motivates students to learn or improves the quality of learning is still debatable. However, there is general agreement on the value of teaching students to use computers as productivity tools during teaching and learning. This includes using computers to do complex calculations, data manipulation, word processing, and presentations, either within the existing school subjects or in special courses as reported by various scholars (Azita, 1999; Clark, 2000; Crook, 1994; Heinich et al. 1996 and 2002; Ken and Anderson 1990 and Zhang, 2000). The first usage involves direct instruction in school subjects like mathematics, sciences, languages and social studies. It also includes drill and practice tutorials, games, simulations and problem solving (Crook, 1994; Hargrave and Kenton, 2001; and Heinich et al. 1996). The second one includes instruction in the use of computer tools such as spreadsheets, programming, word processing, and database management.

There is some value in preparing students for employment- oriented technical training in computer related skills. In this connection, Walker and White (2002) support the need for computer technology integrated training. They report that students who might otherwise be reluctant to enter a school of education's teaching program may consider the more respected and better paying field of education technology because "technology is where the money is in education" (Kenway, 1998:76) in Walker and White, 2002:65). Secondly there is computer literacy as informatics. Here the students should be able to understand social, economic, political and cultural dimensions of information technology. This is important for national development and should aim at closing the gap between the rich and the poor. Thirdly there is the issue of computer literacy for national development of the county (Abas, 1995; Hawkrdge, 1991; and Heinich et al. 1996). Thus, the use of computers as productivity tools led to the introduction of computers into the education system in many countries and was first aimed at teaching students basic computer literacy skills. However, the term computer literacy is vague.

2.11. 2 Defining Computer Literacy Skills

Many researchers have discussed and attempted to describe computer literacy skills (Heinich, et al.1996; Karsten and Roth, 1998; Martin, 1991; VanWeert, 1996 and Hidgon, 1994). According to Heinich, et al. (1996:228) the term computer literacy means "the ability to understand and use computers." They also explain that computer literacy instruction incorporates three types of objectives such as knowledge, skill, and attitude. The knowledge objectives include understanding of the terminology, identifying the components, describing computer applications, and analysing social and ethical issues concerning the use of the computer. Heinich et al. (1996), further state that the skill objectives include learning keyboarding and the ability of the students to use computers for different applications such as word processing, searching databases, and retrieving information. Tiene and Ingram (2001) express similar sentiments.

Moreover, Higdon (1994: 436) noted that the definition of computer literacy depends on the computer literacy course, program, or focus of the teaching process. She points out that if the focus is science based then the computer literacy skills become more specialised in nature. But she concurs with other researchers (Heinich et al. 1996, Abas, 1995; Karsten and Roth 1998) that word processing, spreadsheets, database creation and usage are the basic skills that are necessary for any student to learn in a computer literacy course.

Abas (1995:156) reported a computer literacy program that was highly participatory, known as the Malaysian computers in education project. According to Abas (1995), the Malaysian government funded this computer literacy project. The aim was to involve secondary students actively in learning with computers so as to acquire computer skills, and to understand the computer literacy content. The project team used the computer syllabus prepared by the Ministry of Education, trained teachers, and supplied hardware and software to schools. In this study, the students were expected to cover the following topics in the computer literacy syllabus: introduction to computer systems such as graphics, types of computer systems like spreadsheets; computer systems and operating for example database management system; teaching systems including introduction to programming. The students were also supposed to

learn how computers process data, the effects of computer use and computer ability, its effects on lifestyle, including computer misuse and abuse, different application packages and computer use in the future. In addition, the students were expected to learn word processing and explore computer careers (Abas, 1995:153).

Despite the government effort to provide computer literacy course to students, the project was not effective. Abas noted several problems associated with the project such as lack of trained teachers, frequent transfer of teachers, ineffective in-service course organised for teachers, security of resources and hardware. However, the research findings by Abas (1995) from a developing country provides useful information that the researcher will use during field investigation on the use of computers in Nyanza Province to examine whether computers are used in the same way. Whether the same problems identified by Abas (1995) are prevalent in schools to be investigated. Nevertheless, as a result of these computer education Abas (1995) reported that students learnt a lot of skills. They gained knowledge of computer literacy skills, and they enjoyed the computer classes. Both the teachers and students were highly motivated and significant achievement was realised.

In another development, the aim of teaching students computer literacy skills was also advocated in Kenya. In 1996, the Minister for education Joseph Kamotho announced a plan to incorporate computers into the public secondary school curriculum. The Minister noted that computer skills would enable Kenyan youths that pass through secondary schools to be computer literate. The Minister further emphasized that students would be able to learn all computer literacy skills. These skills he believed would enable the students to compete favourably for employment in the world market and prepare them to pursue advanced studies in Information Technology (Daily Nation Newspaper, 1996).

However, teaching students computer literacy skills also requires schools to integrate technology into the whole school curriculum. This would provide all students with opportunity to participate in computer literacy programs. For example, Blomeyer (1991:123-124) describes an integrated computer literacy program he found at Hilldale Community High School in America. He conducted a case study in this school to assess the use of computers. Blomeyer found that Hilldale had a course in computer literacy for all new students. Blomeyer observed that all students were

expected to be familiar with computers, their history and essential vocabulary involved. In particular, the students were also required to: learn about the impact of computers on society; vocational implications and controversial issues such as privacy and electronic crime; to interact with computers by practising keyboard skills; to observe and write simple programs, and to apply computer skills in related subjects areas. The implementation of computer literacy at Hilldale was guided by a goal which stated that: "an infused computer literacy program taught across Department by all staff reaches more students and diminishes negative impact upon curriculum." A similar study will be carried out by the researcher in secondary schools in Nyanza province to find out how teachers integrate and use computers for literacy programs.

2.11.3 Using the computer to learn how to use word processing

A word processor is a writing tool just like a pen or a pencil. It is a valuable tool used in all introductory computer literacy courses. It is also a powerful versatile tool that can save and recall typed information. Using a word processor saves time, facilitates revisions and improves students' writing. A word processor makes changes easy by erasing, moving and copying text, and all other ordinary typing tasks may be done quickly and efficiently (Nicholas, 1996; Owston and Wilderman, 1997; and Zhang, 2000). In addition, a word processor allows students to easily revise and edit their composition, thereby avoiding too much recopying of the work. This exercise enables students to demonstrate pride in producing legible, neat and attractive piece of work as they practice word processing skills. At the same time, word processing helps to eliminate the physical barriers that students experience as they struggle to make letters. When the students are working teachers are also able to view students' work on the monitors without interfering with the exercise. On the other hand, Zhang (2000) noted that students taking science subjects were not encouraged to use word processing extensively. Therefore, (Heinich et al. (1996:226) stressed the need for every student to be familiar with word processing skills because it helps to improve students writing skills, reading and composing stories. Consequently, many researchers have been concerned about the capabilities of computer word processing to improve students' writing skills.

2.11.3.1 Using Word Processor to improve writing skills

Synder (1993:58) reports on a comparative study in which the writing produced with a word processor was compared to writing with pens. The aims of the research were focused on the quality of work concerned with effects of word processing on written products. The researcher used a controlled comparative study to investigate effects on quality. Synder (1993) noted that the exercise involved drafting or composing work first with a pen, and then the text was transferred to the computer. The participants were required to write short essays. The work was collected and analysed for about four weeks. The results of the study showed that writing of weaker students improved with computers. Other results indicated that gifted students benefited the most.

In another instance, Synder (1993:58) reports on a case study research in which the participants were expected to acquire word processing skills at the same time as they produced computer text to be compared with their essays written by pen. After the analysis was done, the results showed that the writing quality of fast typists was significantly better than quality of slow typists. Synder (1993) concluded that studies in word processing should ensure that students type at least as fast as they write before using computers for writing. The researcher observed also that learning how to use the word processor and mastering keyboard skills could interfere with the quality of the text produced.

Furthermore, Ronald and Widerman (1997:202-218) conducted a three-year experimental study to provide empirical evidence of the impact of word processing on the quality of students' writing and on classroom processes as an integrated part of the elementary curriculum in Canada. The purpose of the study was to investigate whether extensive experience with and ready access to word processing could lead to improvement in students' writing. The researchers used a comparative study of two groups of students. One group consisted of 52 with experience with computer skills, and had access to computer for use at any time. The other group of 58 students had no experience of computer usage and wrote most of their work by hand. Data analysis was done qualitatively and quantitatively. The results were grouped under: assessment of writing quality, volume of writing, use of computers, length of composition, students' writing practices and teachers' practices. From the results, the researchers

concluded that the there was a great improvement in writing quality of the students who had experience with computers skills as opposed to those who had no experience. This was due to the fact that students who scored high marks had access to computers before the experiment was conducted, while those who scored less marks had no or little knowledge of the computer. They also noted that the use of a word processor contributed greatly to the increased quality of the experienced students' writing skills.

Similarly, Zhang (2000: 467) conducted a one-year case study to provide more evidence that using a word processor would produce useful results when measured over a longer period of time. The researcher aimed to determine the effect of word processing on the learning of writing skills of students with learning disabilities. The researcher used a special software computer program designed for students with learning disability in mastering writing skills. Zhang (2000) realised that these students had difficulties with constructing sentences, spelling, developing main ideas, forming paragraphs, and certain other mechanics of writing. In addition, Zhang noted that these students were not motivated to learn and were not even enthusiastic for almost all the academic work. Quite often they did not participate in writing or reading exercises. In order to help these students to be actively involved in writing, a special writing curriculum was designed to include 'ROBO-Writer'as the writing tool for these students. The students practised the exercise three times a week for twenty minutes per period, under the supervision of the teacher in the lab. The results of the study indicated that students' motivation in writing skills increased. Some of them produced well-written pieces of work. They also demonstrated positive attitudes towards writing and some of their work was neatly composed. For example, Zhang, (2000) observed a very good piece of writing produced by one student who used to be lazy and behaved badly in class. This student wrote a composition of three hundred and fifty words within twenty minutes, something he could not do before. The story had very few spelling mistakes and included some compound sentences (Zhang, 2000:473).

In conclusion, Zhang (2000) noted that the special programme ROBO-Writer designed for these students showed very encouraging results and helped to meet the special needs of students with learning difficulties. Zhang suggested that specially

designed tools should be created to help meet the educational needs of disadvantaged learners and that teachers should be involved in designing such curricula.

2.11.3.2. Using Word Processor for revision work

Computer word processing has also been used in the classroom as a tool for revision work. Synder (1993:59) observed a strong interest in the effect of word processors on revision of class work. This was revealed by a number of comparative and case studies documented by Synder (1993). These studies examined the effects of word processing on revision patterns and the quality of the writing produced when word processors are used. The results showed an increase in the frequency of revision exercises. The other findings revealed that a small number of students did not increase their revision exercise when using word processor. Other results indicated less revision with word processor alone, but the revision was more effective when a prompting program was incorporated in the word processing software, which encouraged learners to earry out revision exercises.

2.11.3.3 Using computers to learn Spreadsheets

Heinich et al. (1996: 237) defines a spreadsheet as a page of rows and columns that displays word, numeric, and formula entries. According to them, a spreadsheet can be used to record, average and manipulate data. They point out that spreadsheet programmes are easy to use tools that should be exploited by teachers and students to create graphics from numerical data. At the same time, Alessi and Trollip (1991: 249) add that spreadsheet can also help teachers to budget and to carrying out evaluation of students' examination results. In this connection, Ken and Anderson (1990:83) report that "a teacher may use a spreadsheet that enables her to enter marks for tests throughout the year and automatically calculates class averages for each test as well as maintaining an ongoing average for each student." Similarly, they say that "students may use a spreadsheet to compare the return on funds invested at various rates of interest, and work out income when different taxes are applied to the interest earned." Ken and Anderson (1990) feel that the real power of spreadsheet lies in the way students can ask "What if" questions. This question helps to stimulate students thinking skills and lead the learners to other uses of the spreadsheet. The use of spreadsheets is most applicable in school subjects such as business and economics.

Students can also use spreadsheets in "problems involving time, distance, and speed and relationships between sides, diagonals and angles in two-dimensional figures or edges, faces and verticals in three-dimensional shapes" (Ken and Anderson, 1990: 84). The use of spreadsheets helps students to plan, predict, and to explore given data. Therefore, in order for the students to learn and benefit from the capability of spreadsheets effectively, the teacher needs to play an active role. As the students work with spreadsheet, the teacher should be able to encourage them to explore, challenge their hypotheses, and help them to evaluate their prediction. From the contribution of Ken and Anderson (1990), the use of computers to teach spreadsheets would be effective in helping students in Kenyan secondary schools to learn subjects like business education taught in form one, and Economics taught in form three and form four if the computer could be integrated into the curriculum. This would help to prepare school leavers who opt to pursue advanced commercial courses and even those who join higher education studies in economics and accountancy.

2.11.3.4 Using computers to learn programming

Computers have been used in secondary schools in developed counties like America for the purpose of teaching programming. This is especially true at secondary level (Alkin, 1992). It is claimed that programming skills will lead to a better or more rapid development of higher cognitive skills to "improve thinking, comprehension of basic concepts, problem-solving abilities, planning ability and precision of expression and to lead to the discovery of powerful ideas"(Alkin, 1992:896). Moreover, Underwood (1994) adds that Logo programming provides an environment for the exploration of mathematical concepts. Secondly programming skills will be useful in helping students to find employment and to prepare some students to proceed for more advanced college courses (Alkin, 1992:896). In addition, McCoy (1996:438) reviewed several studies on computer-based mathematics learning and found that programming Logo was used to improve geometrical knowledge. McCoy (1996) noted the importance of teaching students programming skills and reported that in learning programming, students write their own programmes and create mathematical models, then the computer provides immediate feedback to assist them in exploring and refining their knowledge.

Similarly, Makau (1999:16) noted the value of learning programming skills. Makau feels that some aspect of programming should be taught in secondary schools in Kenya. He reports that programming has grown into a profession just like accountancy, law or medicine. But he regrets to point out that while professions like law and accountancy are integrated into the school curriculum, there is almost nothing in the curriculum to prepares students to go into programming. He believes that students who start programming early in their formative years are more likely to be better programmers than those who start after matriculation.

In addition, the need to teach students programming properly using quality materials has also been pointed out by researchers. For example, Cheng-Chih Wu, Lin and Lin (1999: 225) report that the quality of programming textbooks needs to be examined in order to understand how programming examples are used in the textbooks to explain to the students problem-solving concepts. Cheng-Chiu Wu et al. (1999:225) report on a study they conducted to examine 16 high school computer-programming textbooks used in Taiwan. The purpose of the study was to look into the nature and the presentation style of programming examples in the textbooks. The researchers based their examination of the presentation styles of programming into four major problem-solving steps such as: "problem analysis, solution planning, coding and testing/debugging." According to the report, the textbooks were examined by two groups of people: the authors and a high school computer teacher. Furthermore, the assessment focused on the programming examples contained in each textbook. Cheng-Chih Wu et al. (1999) designed three types of questions to guide them in assessing the programming examples objectively and systematically:

> What type of the problems is solved by each programming example?
>
> In what form is each problem-solving step presented in an example?
>
> Which of the four problem-solving steps are specifically described in each example (Cheng-Chiu Wu et al. 1999:229).

In addition, the researchers prepared a list of items that they referred to in relation to the three questions. The results of the study were then compared and indicated that the problems solved by all the examples in the programming textbooks included mathematics problems, graphics problems, syntax-oriented problems, and real-life

problems. Other findings showed lack of detailed explanation of some of the problem-solving steps, in particular problem analysis and testing/debugging. Moreover, other results revealed that most of the authors of high school computer textbooks were not trained in computer science but had attended in-service courses. Finally the researchers recommended that in order to improve the quality of computer programming textbooks for high schools in Taiwan, a list of review criteria should be set up. This recommendation is quite in order more so for developing countries like Kenya where there is lack of qualified teachers to write computer programming text books and consequently use books donated from developed countries and no one knows whether they are relevant to the needs of the students.

2.11.3.5 Using Computers to maintain Databases

A Database is a computer program intended to keep information in an ordered form like a filing system. It is simply a collection of related information organized for quick access to specific items of information. Heinich et al. (1996:408) feel students in schools need to learn how to manage information, to retrieve information, to sort out resources, to organise information and to evaluate their findings. Heinich et al. (1996) add that a database is a versatile and easy to learn computer tool. He believes that students can access databases for inquiry and research studies and at the same time, they can create their own databases. For example, he says that students can design information sheets and questionnaires to collect data, put in relevant facts, and then retrieve the data in different ways. Heinich et al. (1996:232) believe that once the students complete constructing databases as part of their learning exercise they are able to engage in higher-level thinking skills as they analyse and interpret the data. However, Ken and Anderson (1990:75) point out that if the students have never used a database programme before, it is better for the teacher to start by obtaining a database or creating one for them instead of expecting learners to create their own databases. Students need to have time to consider questions related to planning and design of databases before they can embark on any assignment. According to Ken and Anderson, the process of learning database can be broken into three stages. In the first stage the students learn using a database ereated by somebody. Secondly the students build their own database in which the record format has been designed and tested by the teacher. And third, the students investigate the database subjects and then design

the record format for themselves before building their own database for use. Ken and Anderson (1990:74) report on the role of the teacher in using database as a learning tool. They identify five important major roles that the teacher needs to play in helping students to learn database skills. Such roles include:

Teacher as a planner: must link database lesson to the subject matter related to the curriculum, to be familiar with the operations of database, experiment with various databases and lesson ideas, and consult with other teachers who use databases.

Teacher as Facilitator: should be familiar with the subject matter being studied and be conversant with operating database program in order to assist students having difficulties, and to carry out some evaluation.

Teacher as Guide: should be able to use questioning strategies to guide students to higher levels of thinking or to the application of different strategies.

Teacher as Manager: must be able to prepare the necessary disks and classroom resources and collect other relevant materials for students to use in other areas as in decision-making.

Teacher as participant: Accept assistance and ideas from students as part of the collaborative environment and provide learners with plenty of opportunities to learn. In conclusion, the teacher needs to exercise tolerance and patience to help students as they learn database management. The teacher needs to train the students to recognise and appreciate databases, and understand that the ability to use a database effectively is a skill valued in the job market (Ken & Anderson (1990: 74).

Research studies confirm that teaching and learning database is useful and beneficial to both teachers and students. Davis (1995) cited in Berson (1996: 493) describes the result of a small-scale experimental study he conducted using ninth grade students studying social studies. The students were exposed to computer-assisted instruction using a time-line database and concept-mapping program. The researcher used two groups of students. The results showed a significant improvement for students using computers compared to the control group. The students in the experimental classes demonstrated "increased academic achievement, motivation, self-directed thinking, self-initiated activity, construction of memory, analytical analysis, and collaborative

peer interaction." Other results indicated that the experimental students demonstrated positive attitude towards the content and instructional design. Moreover, teachers acknowledged the potential of computer database in teaching social studies compared to using conventional methods. They noted that computer database enabled them to plan their work carefully in order to restructure the learning environment. Thus, computers were integrated and used successfully in teaching and learning information handling skills. Students learnt by doing, acquainted themselves with information and created databases. Such usage of computers in education would be useful if implemented in Kenyan secondary schools.

2.12 Integration and use of computers in curriculum subjects

Computers have been used in developed and developing countries as an instructional medium to improve the quality of teaching and learning. As such computers have been incorporated into many school subjects and are widely used for direct instruction in science experiments, mathematical calculations, social studies, languages, graphics and many other subjects (Sakamoto and Miyashita, 1996; Heinich et al. 1996; and Johnson, 1996).

2.12.1 Learning mathematics with computers

Hunter (1994: 510) reports that, in America, there is a generation of elementary and secondary students who lost interest in mathematics and science despite the fact that educational technology like computers are available in the schools. Consequently, there have been continuous calls for creative and innovative approaches to the teaching of mathematics and science to enable students to understand these subjects better. However, McCoy (1996:438) reviewed several studies on computer-based mathematics learning and found that computers have been used to teach mathematics in three distinct ways: programming logo, computer assisted instruction (CIA) in the form of Micro worlds and as mathematics education tools.

The problem with the teaching of mathematics has been a concern to the USA government. Clark (2000:179) reports that the National Centre for Education Statistics (NCES 1998) revealed that few teachers used computer-based technologies for teaching purposes, and that computers were not integrated into most instructional

curriculum. Therefore, following mounting concern about the low performance in mathematics by students in middle and high schools in America as reported by Hunter (1994:510), Azita (1999:33) carried out an investigation to examine the extent to which computers were being used by middle and high school mathematics teachers in the state of Missouri. The aim of the study was to find out how frequently teachers used computers in their classrooms and to establish specifically the purposes for using the computer, and to identify the factors influencing teachers' decisions about the use of computers. Azita (1999) adopted a questionnaire survey method to collect data. The study involved one hundred and eighty one participants. This sample included 65 middle and 116 high school mathematic teachers representing 65 school districts from urban, rural and suburban areas. After data analysis, the results indicated that teachers did not use computers for any other purpose apart from drill and practice. Azita established that teachers did not have adequate knowledge about when and how computers could be used in teaching and learning mathematics. Further analysis showed that teachers were also not effectively trained in the use of computers to teach mathematics. Azita suggested that there is need to encourage teachers to find more time to teach with computers and thereby to interact collectively with students as they learn mathematics. Azita recommended the integration of computers into mathematics curriculum in order to provide a problem-solving environment for the learners and the teachers. Azita believed this would instil a sense of being more responsible and committed to the use of computers in teaching and learning mathematics.

In conclusion, the researcher noted that mathematics teachers were not adequately trained in the use of computers and, therefore, were not convinced about the usefulness of computers in their lesson presentation. Further results indicated that teachers did not recognize the potential of computers in enhancing the curriculum they teach. Due to lack of teachers' positive beliefs on the capabilities of computers to improve students learning mathematics, and their ineffective training, Azita suggested that teachers must be competent and have confidence about their understanding of mathematics content. Azita felt also that teachers must posses adequate knowledge about the pedagogical issues related to teaching mathematics content effectively. Azita stressed that if teachers are to improve the standard of mathematics education, they should have access to computers and they should have adequate knowledge about the software and its capabilities. They should also be conversant with the use of

computers in teaching and learning. Above all, Azita recommended that in-service training on new technologies should be provided to maths teachers. And lastly, he recommended that there is need for teachers to be supported by their communities in order to perform their work effectively.

2.12.2. Learning science with computers

Teaching and learning science, whether in developed or developing countries, requires the use of various teaching aids/apparatus. Again, in most areas of science education, the use of technology is quite acceptable and highly recommended to enhance learning. Researchers have pointed out the capabilities of computers to improve students' scientific knowledge. For example, Woodrow (1994:579) noted the value of integrating technology into science teaching and stated that "computer-based technology gives science teachers access to a rich variety of textual materials and graphic information." Woodrow (1994) explained that the use of computers provides new instructional strategies which the teacher and students can employ. This includes sophisticated laboratory and simulation tools.

Yet many science teachers shy away from incorporating technology into their teaching and learning process despite the availability of computers in the schools. (Clark, 2000:179) pointed out that few teachers used computer-based technologies for instructional purposes and that computers are not being integrated into most instructional curricula. Heinich et al. (1996:236) noted that advancements in technology have now made it possible to integrate computers into the school curriculum and hence into the teaching of science. He stressed that the emphasis in teaching and learning should now be on providing learners with the opportunities for problem solving. This, he believed should include cooperative learning methods which may not necessarily require additional special training on the part of the users. He further stated that computers are now more of a natural tool to use in teaching and learning because a wide variety of software is available. This provides students with experiences to work together to solve complex problems. He also believes that when the computer is integrated into the curriculum, students will be able to incorporate several different types of computer applications to explore a problem in a particular field. So the traditional method of teacher-centred instruction used by most teachers

will change. The students will learn by doing which is the corner stone of all science learning. The students will also learn to explore topics in science and create meaningful learning experiences for themselves (Heinich et al 1996:236).

When the computer is integrated into the classroom the role of the teacher changes from that of the information provider to that of a facilitator of learning (Clark, 2000:180). For example, to integrate technology into teaching and learning effectively, Heinich et al. (1996:136) suggests (a very simple integration approach as an example) that the teacher could give students an assignment to prepare a report on ecology. A group of students would use a computer database to search for resources to use in compiling the report. They could also send electronic messages to people in various places requesting relevant information. In addition, the students could use a data base program to store and sort out their information. At the end of their research they could use a word processor and hyper media program to prepare a written document. Lastly, the students would use a projector to display their findings to the rest of the class. In this type of computer integration into learning science, Heinch et al. (1996) emphasises that the teacher must provide opportunities for learners to complete their work and learn effectively. If this strategy is to be effective, the teacher needs to plan in advance to integrate the computer into teaching and learning, prepare good learning environment for the students, and work in collaboration with the students during the research period. After the presentation, the teacher could organize for a science quiz session for all students or give further assignments.

In another instance, Christman and Badgett (1999:135-143) carried out a comparative study to evaluate the effectiveness of CAI on the science achievement of American students following two different teaching methods. The assessment covered four subject areas: General science, Physics, Chemistry and Biology. The participants were drawn from urban, suburban and rural secondary schools. The sample included a total of 2343 students. The purpose of the study was to establish the differences that existed between the academic achievement levels of science students who used computer-assisted instruction and those who used traditional approaches to learn biology, general science, chemistry and physics. The experimental group that used systematically designed traditional instruction supplemented with CAI obtained significantly better academic achievement compared to the control group that adopted

a conventional teaching approach. Further results indicated that CAI was more effective among science students living in urban areas followed by those in suburban and those from rural areas had the lowest test score. In conclusion, Christman and Badgett (1999) appealed for more research to establish whether CAI could be more effective or ineffective among groups of students or within certain academic areas so as to support effective use of CAI in science subjects. This study is potentially relevant to the proposed study in Kenya because it will also consider differences in computer use among urban, suburban and rural schools. In fact, some of the apparent limitations of the Christman and Badgett study will be used to guide the data analysis in the Kenya study. In particular, the Kenya study will take into consideration the differences in the availability of computers between urban, suburban and rural schools, a factor that seems to have been overlooked in the Christman and Badgett (1999) study.

Researchers who support computer integrated learning in science subjects apparently generally do so because of their conviction that one kind of medium will supplement and improve the effectiveness of another media, thereby making the teaching/learning period an exciting experience to both the teacher and students. The use of a variety of media seems to improve the effectiveness of media like computers (Hargrave & Kenton, 2001). This is because there is no single medium that is adequately suitable to meet all students' needs and even the most excellent technology must be frequently supplemented with discussions, demonstrations, displays experiments and even field trips.

Similarly, McRobbie and Thomas (2001:142) conducted an experimental study to investigate the factors that influenced teachers and students to use Microcomputer-Based Laboratory technology in chemistry lessons. The participants were drawn from an Independent high school located in a Metropolitan city in Brisbane, Australia. The sample of the study consisted of 12 males and 9 females (15-16 years) studying Chemistry as part of a general science course in year eight, nine, and ten. The researcher used two types of experiments that involved the use of MBL and covered topics such as: boyle's law, pressure-volume relationship in gases, and pressure-temperature relationship in gas.

These scholars used video recordings, tape recording and face-to-face interviews to collect data. At the end of the experiment the data were analysed and the results showed mixed responses. In the first place, the subject teacher supported the use of MBL to learn science but was not ready to change her methods of teaching science. She believed in a teacher-centred approach. For example she responded "I feel most comfortable with a teacher-centred environment" and "I only feel comfortable when its' teacher-centred," Moreover, some students responded positively. One student said "I like how we are being taught" ---practical work is used "to prove theories that we are doing in class"- -most of them are done to prove a point"- - "it's a break from the textbook" - -"more than anything else they are more enjoyable." At the same time some students did not like the use of Microcomputer-Based Laboratories. One of the students said "I just saw the computer as a measuring device."

Such opposing views about the new technologies indicate that there is need for background studies to be undertaken before an experimental study is carried out. Starting from the teacher would be an ideal approach. Once the teacher is comfortable with the technology, the students will also be willing to use the computer because they will have seen the teacher using it in teaching them. The experience of the teacher is also an important factor to consider. In this experiment the teacher was not trained in computer applications and did not regard the technology as a potential medium to improve students' scientific knowledge. Therefore, for any meaningful learning to take place in an innovative venture like the use of MBL, the role and experience of the teacher needs to be examined carefully. The implementation of computers in education cannot be effective if teachers are not ready for using the technology. Teachers' beliefs and fears about new technologies like the MBL in learning science need to be addressed first before an experiment is undertaken.

Although computers have been widely recognised as a potential tool for teaching and learning science subjects, the effective utilisation of the program is required if students and teachers are to benefit. Hargrave and Kenton (2000:47) feel that what has been lacking is instructional methods that take advantage of the computer and engage students in advanced ways of thinking. The educational value of computer programmes depends on many factors in a similar way to traditional instruction. Some of these factors include: the content of the program; its relevance; the teachers' ability

to use and to guide the students; students' own ability and interests to learn; and the different application techniques employed by the teachers.

The availability or non-availability of the above factors contributes to the success or failure of computer program integrated learning. In this connection however, Hargrave and Kenton (2000: 47-56) report some procedures to be followed in which the teacher's role is only to guide the students, prepare the learning environment and take part in the program with the students. They highlight specific value attached to effective ways of using a computer simulated laboratory that involve:

- Preparatory activities on the part of the teacher,
- Pre-Instructional simulations and
- Post-Instructional simulations

According to Hargrave and Kenton (2000:47) computer simulations are used to teach students many topics in science subjects, because the "mental and physical dexterity required to use a simulation that engages students in learning." Hargrave and Kenton (2000) report that simulation is often used to stimulate students' interest in a topic in order to promote active learning of problem solving and the study process. As such, computer simulations have been employed in science education to teach students about "cardio-vascular circulation, fire, heat, velocity and electricity." All these require careful planning and preparation by the teacher in advance. Effective use of computer simulations depends upon the teachers' ingenuity in bringing to bear on the materials those aspects of their students' experience that make the program important and significant for them. Hargrave and Kenton (2000) recommend that when the teacher plans to use computer simulations the students should first learn the content of the lesson. They suggest that the teacher needs to use appropriate traditional teaching methods such as lecturing to present the essential important information to the students. Then the computer simulation is used either to supplement the content or to reinforce what the teacher has taught. The scholars also believed that an appropriate computer simulation could be the main source of information and understanding for students.

2.12.2.1 Pre-Instructional Simulation

Pre-instructional simulations are one special form of pre-instructional strategy, that is a strategy for preparing students to learn. In a general sense, pre-instructional strategies fall into four categories: overviews, advance organizers, questions and statements of learning objectives. Each of these strategies can be an effective way of focusing students' attention on the important things they are to learn and motivating them to engage in learning.

Furthermore, Hargrave and Kenton (2000:50-51) explain that pre-instructional simulations provide students with the opportunities to develop new conceptions. For example the scholars explain that before formal teaching "about photosynthesis, students in a fourth grade class use a computer simulation about how plants receive nutrients." Hargrave and Kenton (2000) believe that using the simulation prior to formal instruction allows the students to activate or test their experience about plant nutrients or start to develop a personal conception about plant nutrients. In this usage, pre-instructional simulation can serve as a foundation for further learning and assist in the development of students' detailed knowledge about the topic. During this time the teachers' role is to provide more assistance to the students to learn effectively from the simulation program.

2.12.2.2 Post-Instructional Simulations

Hargrave and Kenton (2000) explain that post-instructional simulation is used to test students' knowledge of content. They also emphasize that post-instructional simulations place students in unique and specific learning roles in which they must activate or utilize previously acquired knowledge. They give a vivid example of how computer simulation could be used after the teacher has taught a lesson on the respiratory system. Students in a biology class use a computer simulation to review the functions of each organ in the respiratory system. So in this way, these scholars report that simulation is used to reinforce students' knowledge of the content presented during formal teaching. I support their point of view with my experience with using media like cassette tape recording that teachers can use either to introduce the lesson, as the main part of the lesson or to reinforce what the teacher has taught. During post-instructional simulations there is a need also for the teacher to assist the

learners to benefit from computer simulations by checking if they are identifying specific points discussed before and clarifying what was not understood by the students so as to elaborate on it.

2.12.3 Learning social studies with computers

Computers have also been used successfully in teaching and learning social studies. This includes using technology to teach subjects like economics, geography, history and languages to mention a few. Some of the early studies found positive gains in secondary students' performance and attitudes towards the subject matter, and in using computers for storage and retrieval of information compared with using traditional teaching methods. According to Berson (1996:489) computers have been integrated effectively into learning games and simulations in social studies. He reports that computer simulation enables students to engage in activities that are not easily taught adequately by traditional approaches. For example Berson (1996) reports on the secondary school students involved in the creation of computer-based simulations to represent system dynamics. The students in an experimental course on War and Revolution were introduced to the Structural Thinking Experimental Learning Laboratory With Animation. The students engaged in model construction that required the use of analytical and problem solving skills. Berson (1996) noted that students created and revised models of political-social events. The impact of this curricular approach on students' content knowledge and higher order thinking skills was not determined empirically. Berson (1996486-487) believed that simulation facilitates the development of students' problem solving skills, and puts them in the role of decision-makers. By using the computer students can gain access to expensive knowledge links and broaden their exposure to diverse people and perspectives. He feels also that simulation improves students' higher level thinking skill development, and exposes learners to information that widens their knowledge about the content area. Berson acknowledges the power of computer simulation to motivate students, and to improve their intellectual curiosity, sense of personal control and perseverance.

In addition, Berson (1996:491-493) states that the major reason for integrating computers into the social studies curriculum is the belief that computers encourage problem solving and facilitating an inquiry-driven approach to leaning. A study by

Crozier and Gaffield (1990: 72-77) cited in Berson (1996:493), found that integrating computers into the social studies curriculum aids learners in the development of "historical imagination, skills of critical analysis, and understanding of complexity of American history." Further results indicated that students increased their imagination and creativity and the computer encouraged them to develop insight, to examine relationships and to analyse patterns reflective of their thinking about historical processes. This is a clear example of the ability of appropriate computer simulations to engage students in higher order thinking-one of the important aspects of productive teaching and learning.

Moreover, in a recent study on the use of computers to learn social studies, Addison and Fridman (1997:157-160) carried out research with students from Westridge High School in South Africa to examine the use of specialist software in teaching accounting. The aim of the study was to contribute to an understanding of ways in which computers might be employed to address pressing educational concerns in South Africa, and in particular the use of the new software for teaching Accounting skills in secondary schools. The sample of the study included 22 boys and 33 girls. The researchers used a special locally developed accounting software package for three to four weeks. The students worked in pairs. At the end of the study, the students were each given a questionnaire based on the study package. Data analysis showed that student's knowledge of accounting increased and the students were motivated and enjoyed using computers to learn accountancy. Despite the learning gains by most of the students, the researchers noted several problems such as lack of enough facilities in the computer centre for all students to work comfortably and independently, the weaker students did not benefit, and students' attention was also distracted by the noise from the printer. Furthermore, the researchers compared the results of the students at Westridge High School with the result of a similar group of students from another school who did not use computers and there was no significance difference in their achievements. However, the students who used computers showed positive gains. The use of a specialist software package improved students understanding of Accounting principles, their understanding of the relevance of Accounting for a business, and the software enhanced interest in learning Accounting at schools. As a result of the positive gains of the pilot study, the researchers recommended another study to cover more schools. A similar comparative

study conducted by Klein and Doran (1999) on the use of computer simulation in accounting indicated high performance but that the students who worked individually expressed significant gain. This finding confirms the potential of computers for individualized instruction as reported by Ellington and Race (1993: 222).

2.12.4 Using computers to improve learning foreign languages

There is a good reason to believe that computers can be used to improve and promote the development of students' communication skills, more so in learning foreign languages such as English (Crook, 1994; Heinich et al. 1996; Herman, 1995, Hurst 1996 and Barbara 1994). From my own experience, the computer can provide the learners with a ready-made dictionary. The student does not waste time looking for a book dictionary. The computer dictionary gives the learner instant access to word meanings without a time-consuming search and with less disruption of reading the text. It is motivating and easy for students to refer to it in all reading and vocabulary development.

The value of computers is also noted in teaching and learning sentence construction, comprehension, composing and in creative writing. Heinich et al. (1996:242) recognize the ability of the computer in teaching English language and report that "spelling and grammar checking are available to students. A thesaurus makes it easier for them to find the right word for a specific situation." Far back in 1990, Ken and Anderson also recorded the capabilities of the computer as a tool to teach students communication skill and stated that:

> Computer communications provides students with an enormous amount of motivation for writing. There are many opportunities to develop skills in typing, reading comprehension, written composition, and oral communication. At a personal level, students begin to feel that they are in control and are responsible for the decisions they make (p.69)

Thus, using computers for teaching and learning languages helps students to have confidence in effective communication that requires careful integration into all language programmes taught in secondary schools. In fact Carol (1997: 52-59) felt that integrating computers into teaching English language was an ideal step. Carol

(1997) carried out a survey in West Midland Secondary Schools in England. She used a questionnaire survey method to examine the use of computers in modern language teaching. Two hundred and fifty secondary schools received questionnaires but only 87 Heads of Department responded and the analysis revealed several important issues concerning computer integration and classroom use in the sample schools. Carol (1997) noted that school policy, departmental policy, availability of hardware and software, access, policy on planning and use of the computers by teachers from the language department were crucial. However, with regards to the utilization of computers in learning modern languages, 56% of the departmental heads replied that computers were an integrated part of their schemes of work. 28% were working towards the integration and 14% said computers were not integrated into their departmental schemes of work. 4% of the 14% indicated that it was up to the individual teacher to integrate computers into teaching and learning languages. Furthermore, sixty-two of the departmental heads reported that they had a whole school policy on the use of computers. Some of the heads recommended that integration of computers was best by subject topic areas, and half of the departmental heads suggested specific topic activities and relevant software in their schemes of work. Carol found also that computers were used mostly in revision work, vocabulary and producing text, especially writing letters. Pascoe (1994:615-617) qualitative and quantitative research reported similar findings but he noted specifically high gains on students' composition work.

So the computer as a tool for teaching and learning has been successfully integrated into English language classes to help improve teaching and learning English in schools. The use of computer technology in language teaching could be motivating to students in Kenya, especially if it can be employed in teaching the Kiswahili language in secondary schools in Nyanza province where the standard of written Kiswahili is low.

2.12.5 Using computers to learn graphics

According to Heinich et al. (1996), graphics are two-dimensional non-photographic materials designed to communicate a specific message to the viewer. Graphics are instructional material that summarizes significant information and ideas through a

combination of drawings, word symbols and pictures. Graphics include display materials such as charts, graphs, diagrams, posters, cartoons and comics. In teaching and learning, graphics assist in focusing attention on core information and in conveying ideas in a manner that is easy to capture and retain in memory. Many researchers have also reported the ability of the computer as a tool for teaching and learning graphics (Crook, 1994; Heinich et al. 1996; San Jose, 1995). However, Alessi and Trollip (1991:38) add that new software for microcomputers makes it increasingly easy for teachers and students to produce graphic materials for teaching and learning. Alessi and Trollip (1991:38) state that there are many ways a teacher can employ graphics in lesson presentation. Some of these approaches include: using graphics as the primary information: for example, the picture can be used as the source of primary information. They can also be used as an analogy: the picture could be the main concept and as a cue, the graphics could be used for focusing attention on important text information. Alessi and Trollip believe that a computer integrated education approach excels in graphical expressions.

Crook (1994:22) shares these views with Alessi and Trollip. Crook (1994) reports that using computers as tool can offer a different and distinctive kind of experience in graphic media. Crook (1994) cites his own research on young children using screen-painting programs. This study suggested that the computer tools could cultivate a more editorial attitude towards graphic creations. Crook (1994) noted that using computers to produce or learn graphics extends the learners' experience of drawing, writing, classifying and calculating. This seemed an exciting enterprise to the students. Crook (1994) observed that students' classroom activities involved production of geometrical shapes. Moreover, Crook (1994) found that the resources of Logo-based turtle graphics provided learners with a new device for manipulating some of the familiar graphic products that generated visual patterns though controlled execution of various computer commands and procedures.

Consequently, San Jose (1995:211) believes that a computer integrated education approach is the best for teaching students graphics skills. He also points out that in the field of drawing and design, many professional graphics artists now rely on the power of computers. San Jose feels that any curriculum attempting to be complete must include the use of computer aided design and drawing.

2.13 Summary

After examining all the research work reviewed, it is important to point out that computers offer the potential to greatly enhance teaching and learning in the classroom. But due to their complex technical nature, this potential has not always been realised to the full. This has been as a result of the slow pace of integrating computers into curriculum instruction. Teachers need to be encouraged to use computers so as to improve the quality of learning, to motivate students and to provide variety in lesson presentation rather than using only traditional methods of teaching.

In this chapter I have described the research findings on the use of computers as productivity tools within existing school subjects or in special courses. This has included instruction in computer literacy skills-the ability of students to use word processors, spreadsheets, database management and programming. It has also been established that computers are widely used as a tool for direct instruction in subjects like mathematics, science, language, and in social studies. The integration and use of computers illustrates how it is possible to bring another teacher into the classroom to help to reduce the monotony of the classroom teacher's voice and in order to avoid students' boredom. In this usage, teachers need to be conversant and competent with the classroom use of technology. The emphasis should be on the need to integrate and use computers to help meet certain educational and specific individual needs of students in relation to instructional objectives and the country's national goals of education.

Thc use of computers is now an integral part of classroom instruction in most of the developed countries and is regarded as a valuable tool for teaching and learning. The integration and use of computer has been widely argued to be capable of providing uniform education to all learners in the class. Students differ widely in their ability to learn and comprehend concepts or ideas in classroom teaching. So the use of computers helps to meet individual learners' needs. However, like all other media meant for teaching and learning, computers have disadvantages as a medium of instruction. For example, computer-based instruction lacks face-to-face contact. It cannot cover a wide area of the syllabus, and some programmes could be unsuitable to students (especially commercially produced programmes).

Despite some of the limitations, computers furnish fresh curricular resources. They can provide teachers and students with opportunities to learn by discovery, and to improve in various subjects. In science for example, computers are useful in carrying out complex scientific experiments. They excel in graphical expressions. Computers encourage students to want to learn. The use of computers has enabled many students to improve their communication skills. If used appropriately, computers could help teachers and students to improve the quality of learning. Consequently, effective utilization of classroom computers requires a dynamic integration process, whereby programs and uses are adapted over time to increase total instructional efficiency. To achieve this, computer software applications need to provide relevant and quality materials to be integrated into teaching and learning.

The main purpose of this review was to identify and examine various ways in which computers have been used and integrated into teaching and learning. It has examined previous studies in developed and developing countries which merit further investigation in relation to Nyanza Province. This review has indicated that the computer is a powerful tool capable of improving the quality of learning science, mathematics, and excels in graphical expressions. The review has supported my research work by identifying two main questions to be explored in the case studies in Nyanza Province, Kenya. For example, the study by Clark (2000), and Zhang (2000) indicated that computers were used into the classroom teaching and teachers were actively involved, and collaborated with learners. In my studies, I will investigate and examine how teachers use computers and explore issues of whether computers are integrated and used for similar reasons in Nyanza Province. In the next chapter, the researcher examines the factors that encourage and affect the integration and use of computers in teaching and learning.