EFFECTS OF COMPUTER BASED LEARNING USE ON ACADEMIC PERFORMANCE IN MATHEMATICS AMONG LEARNERS WITH PHYSICAL DISABILITIES IN SECONDARY SCHOOLS IN KENYA

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ABSTRACT

Learners with special needs in education are of diverse categories and include those with physical disabilities (PD). Among the PD are those with postures that make them strain when they stay in a given position for long. This affects their learning ability by reducing their ease in the manipulation of math concepts as a result of poor fine motor coordination. This study focused on learners with poor fine motor coordination. Mathematics has been the worst performed subject among learners with PD in the Kenya Certificate of Secondary Education (KCSE) as indicated in the results from the year 2008 to 2013. The mean scores were 1.102; 1.004; 1.502; 1.342; 1.209 and 1.303 respectively. This was below the national average of 3.155 over the same period of time. Traditional mode of instruction (TI) had been the only method of teaching the learners. There was therefore need to device ways that would enable the learners to participate in learning with ease. Computer based learning (CBL) had been reported to enhance the teaching and learning of complex concepts in accounting and physics and could as well provide solution in the teaching of mathematics among the learners with PD. The purpose of this study was therefore to establish the Effects of CBL use on Mathematics Performance among learners with PD in Secondary schools in Kenya. Objectives of the study were to; Asses the instructional strategies used in teaching mathematics to learners with PD in secondary schools in Kenya, Determine the effects of CBL use on mathematics performance among learners with PD in secondary schools in Kenya and establish the challenges faced by the learners with PD in learning mathematics using CBL methods in Kenya. A pre-test quasi experimental and correlation research designs were employed. Winnie and Butter, (1994) model was adapted and conceptualized for this study. Population of the study was 156 form three students and 7 mathematics teachers. Saturated sampling technique was used to select 128 form three students and the 5 mathematics teachers from three secondary schools for learners with PD in Kenya. The instruments used were Computer Assisted Statistics Text (CAST), Student Interview Guide (SIG) and Focus Group discussion for Teachers (FGDT). Validity of research instruments was established by experts in the department of special needs education. Reliability of student questionnaire was established using Cronbach's Coefficient Alpha and accepted a 0.70 or above at *p* value of 0.05. Quantitative data was analyzed using Analysis of variance and Pearson's product moment correlation. Qualitative data was analyzed for content in emerging themes and sub-themes and reported verbatim. Findings of the study revealed that the teaching strategies adopted by the teachers were mainly: chalk and talk, with much emphasis on Individualized Educational Instruction and collaborative teaching. There was statistically significant difference in the use of CBL method $\{F(2,125) = 33.14, p = .000\}$ compared to the traditional method. The study also revealed that students experienced challenges such as unmodified input systems of the computers that suited learners with PD, inadequate computer software and teachers competence in the use of CBL. The study recommended provision of diversity of mathematics software tailored towards the needs of learners with PD and modifying the input systems in computers to suit learners with PD. The findings will help the ministry of education and other relevant stakeholders in developing a method that could improve the performance in mathematics among the learners with PD.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

This chapter discussed on the background information, statement of the problem, purpose of the study, objectives of the study, research questions, research hypothesis, scope of the study, significance of the study, limitations and delimitations of the study, theoretical framework, conceptual framework and operational definitions of terms used.

1.2 Background to the Study

Mathematics has been recognized worldwide as a vital tool for survival particularly in areas of science and technology. Mathematics education therefore has increasingly become science and technological oriented. The 21st century has witnessed an advanced development in information communication and technology (ICT) through the introduction of undersea fibre optic cables which link the whole world through the computer (internet), making the world a global village (Deepark & Turner, 2006). Further to these, there has been an increase in access to computers due to tremendous advancement witnessed in computer hardware and software engineering which has resulted in the lowering of the prices of desktop and laptop computers, (Garrison & Anderson, 2003).

Educational technology is an interdisciplinary field which is comprised of a diverse set of disciplines and knowledge domains, (Bhagwan, 2005). It is mainly concerned with the use of various forms of instructional modes that aids in simplifying abstract concepts during the teaching and learning process. Computer Based Learning (CBL) refers to the use of a computer as an instructional material in the teaching learning process. In the process, the teacher gives learners computer directions in a programming language, use the computer as a tool using in-built software such as word processors and spread sheets or as a tutor the learners take drills, practice, tutorial, use exploration tools or simulation, and at times test using the computer (Deepark & Turner, 2006).

The availability of Information and Communication Technology (ICT) tools and programs spread all over the world. Instructors are supplementing the traditional lecture with teaching strategies that emphasize understanding of concepts, active learning, and relevant applications (Armington, 2003; Kinney, 2001). It is widely accepted that solely addressing the mathematics skills of students is not sufficient (Hall and Pontoon, 2005). Math anxiety, negative attitudes, poor study skills, and lack of responsibility for learning are also being addressed. In a recent report by the World Bank (2008) it is made clear that the Jordanian educational system, like other educational systems in the Middle East and North Africa (MENA region), depends heavily on memorization, definition, knowledge of facts and concepts. It fails to concentrate on learning and the usage of new approaches or techniques that reinforce creative and critical thinking among students.

Audio-visual education a branch of education technology emerged as a discipline in the 1920s, when film technology was developing rapidly (Hughes, 1962). A visual instruction movement arose, which encouraged the use of visual materials to make abstract ideas more comprehensible to students. As sound technology improved, the movement became known as audio-visual instruction. Educators at that time viewed audio-visuals only as aids to teachers. Not until World

War II, when the armed services used audio-visual materials to train large numbers of persons in short periods of time, did the potential of these devices as primary sources of instruction become apparent (Blomeyer & Martin, 1991). In the 1950s and '60s, developments in communications theory and systems concepts led to studies of the educational process, its elements, and their interrelationships (Hughes, 1962). Among these elements are the teacher, the teaching methods, the information conveyed, the materials used, the student, and the student's responses. As a result of these studies, the field of audio-visuals shifted its emphasis from devices and materials to the examination of the teaching-learning process. The field was now known as audio-visual communications and educational technology, and audio-visual materials were viewed as an integral part of the educational system (Laswell, & Dwight, 1948).

As the technology improved, educational capabilities increased correspondingly. According to Deepark and Turner (2006), the emergence of inexpensive computer technology and mass storage media, including optical videodiscs and compact disks, has given instructional technologists better tools with which to work. Compact disks (the CD-ROM and CD-I) are used to store large amounts of data, such as encyclopaedias or motion pictures. In the new interactive delivery stations with computers and CD-ROM, CD-I, or videodiscs, a student who is interested in a particular topic can first scan an electronic encyclopaedia, then view a film on the subject or look at related topics at the touch of a button (Garrison & Anderson, 2003). These teaching stations combine the advantages of reference materials, still pictures, motion pictures, television, and computer-aided instruction. With even newer technologies now being developed, such learning stations are now commonplace in homes for both entertainment and educational purposes. According to Hung and Khine (2006); the appearance of microcomputers has initiated graphic animation and implementation of an increased variety of instructional strategies, such as simulation and modeling. Significant CBL projects emerging from these efforts in the early 1970's included the Programmed Logic for Automatic Teaching operations (Sherwin, 1978).

Various authors document the immense benefits that these materials bring to the classroom. For instance, Hung and Khine (2006) asserts that calculus students who used mathematica (a Mathematics software) were better able to make connections between numerical, graphical and symbolic representations than students learning via traditional methods such as lecture method, historical method, book and pencil exercises and teacher-centred teaching. The assertion is supported by Hung and Khine (2006) who found that engineering mechanics students who used mathematica solved problems requiring calculus more conceptually when compared to students learning via traditional methods such as lecture method, historical method, book and pencil exercises and teacher-centred teaching focusing only on the procedures. Hung and Khine (2006) argue that computers can make a unique contribution to the clarification and correction of commonly held misconceptions of phenomenon by visualizing those ideas. For instance, he suggests that the computer can be used to form a representation for the phenomenon in which all the relational and Mathematical wave equations (trigonometry iii) are embedded within the program code and reflected on the screen by the use of graphics and visuals. Such use, according to Hung and Khine (2006) makes the computer an efficient tool to clarify scientific understanding of waves and other Mathematical topics.

Over the past two decades or so, technology has had a significant impact on the educational system. Drucker stressed the idea that new technologies will force us to shift from teaching to learning, (Drucker, 1999). Research into teaching and learning with new technologies is currently a very dynamic, high-profile and relevant area of educational enquiry (Muller, 2006). Multimedia technology is probably one of the most exciting innovations in the information age. The rapid growth of multimedia technologies over the last decade has brought about fundamental changes to computing, entertainment, and education (Norhayati & Siew 2004).

Multimedia technologies and applications are probably some of the most exciting innovations in the age of information evolution. They helped and got help from the Internet and other communication and computer inventions. Multimedia has the potential to create high quality learning environments, with the capability of creating a more realistic learning context through its different media. It also helps by allowing all learners even those with physical disabilities to take better control of the classroom especially when the class size is large. For effective learning to take place, there is active interaction of both cognitive and psychomotor dormains, (Hung & Khine 2006). A learner writes down with the limbs what he has understood and for a learner whose fine motor coordination is impaired due to disability, use of adapted computers will bridge this gap by increasing the speed of manipulating the tasks. Mathematics as a subject involves more of manipulation and with the degenerative disorders in limbs among the learners with effective learning is inhibited. Retention improves with psychomotor. By allowing a learner to take control, interactive multimedia can provide an effective learning environment to learners with PD, (Margie & Liu, 1996).

A study of the mathematical achievement of high school students in Nigeria who were randomly assigned to computer based learning (CBL) or traditional instruction (TI) revealed a significantly higher mean for the CBL assisted group (Olusi, 2008). CBL has also had positive effects for calculus students (McSweeney, 2003), psychology students (Brothen & Wambach, 2000), and low-ability students (Hannafin & Foshay, 2008). In all these studies however, little is mentioned about the effect of CBL on mathematics performance and motivation towards the subject by learners with physical disabilities in Kenya.

Computer based learning (CBL) is a technology with enhanced kind of learning which offers several advantages over traditional schooling. Although this field has witnessed a huge progress in providing alternative teaching strategies for the learners with disabilities in general, there is yet more to be done in as far as improving the mathematics performance for learners with PD is concern, (Johnson and Johnson, 1995). There is great number of the learners with physical disabilities who cannot study because of their physical conditions. This modern system of learning was alleged to provide them with an equal opportunity to study, as their regular friends and relatives. It was reported to also increase motivation amongst this category of learners and enable them to manipulate learning materials with ease hence increasing their ability to achieve in complex subjects like accounting (Kagan, 1990; Lerman 1997). While proper access to buildings and facilities is generally of primary concern, access to the curriculum and learning is of equal importance to children with physical disabilities, (Kagan, 1990). Computer based learning include the use of head pointers or head mice (particularly optical); keyboard/mouse accessibility utilities and key guards; overlaid keyboards; predictive word processors; switches and scanning systems; touch pads; tracker balls and speech recognition, (Johnson & Johnson 1995).

Oslon, (1988) notes that computer based techniques can be used both as a replacement for conventional approaches and for instruction that do not result in learning. It is the teachers' structuring and framing of information and communication technology (ICT) supported tasks, which allow pupils to realize their own potential, and that of technology (Scot, 1997; Davies & Selyn, 1999). CBL produces positive results in the teaching of difficult subjects or where pupil motivation is low, (Makau, 1990; Alessi & Trollip, 1991; Blomeyer & Martin, 1991; Garcia, 1992; Voogt, 1993; Kiboss, 2002). The authors concur that CBL is an effective tool for improving the students' performance by motivating them in learning. Instructional technologies can be integrated as an effective component in any area of subject matter when instructional personnel understand the practical significance of the new methods and delivery systems, (Blomeyer & Martin, 1991; Crawford, 1999).

Most of the teachers' failure to model the use of the technology in their teaching may be attributed to lack of training on the use of technology, lack of confidence in the new medium and insufficient funding put in the infrastructure in schools, (Gaed, 1995; Davies & Selwyn, 1999). Despite the shortcomings, computers open new ways of learning which go beyond the traditional classroom activity, help teachers to do better what they already know (Bostrom, 1982) and act as amplifiers of existing practice, (Philips, 1984; Boucher, 1998). They also stimulate the intellectual climate and social interaction among pupils, (Papert, 1980; Crawford, 1999). This led to the choice of CBL to be used in the teaching of mathematics in secondary schools in order to determine its effects on learner's performance in mathematics.

In Kenya, the history of the learners with PD date back to post Second World War period, when service men who had been injured in wars were put together to be facilitated through provision of treatment services, (Christensen, 1997). Some of the earliest schools that were started in Kenya to cater for the education of children with physical disabilities included Dagoretti Children's Home that was started in 1961 by the Red Cross Society and the Joytown School for the physically disabled in Kisumu that was started in 1962 by the Salvation Army.

Although there are numerous research on the positive impacts of CBL in foreign countries and higher institutions of learning including institutes of technology, polytechnics and universities in Kenya, the high school Mathematics teachers have done very little to introduce the same in their classroom teaching and learning process. With the Free Day Secondary Education (FDSE) provided by the Kenya Government, secondary schools are increasingly acquiring computers for computer science subject which is an optional subject, thereby ensuring that the infrastructure is put in place awaiting implementation (MOEST, 2003-2004).

1.3 Theoretical Background to the study

By acknowledging the learner as an "agent," the theories recognize that a student does not merely observe the surroundings and receive information available but also steps forward to define goals and seek specific information from papers, text books or the teacher. The method and physical acts elicit information that the student seeks for the purpose of guiding subsequent thinking and acting. The student develops problem- solving skills by organizing the internal and external instructional events. The internal factors are the child's maturation level and intrinsic need for equilibrium while the external factors include the social transmission of knowledge and environmental experience to influence development.

On receiving the message, the mind of the learner processes information through the following stages (Allessi & Trollip, 1991): The encoding stage is where the message is put in some form ready for communication. These could be physical touch; visible movements of some portion of the body or using symbols like for speak pictures or writing; the transmitting in the signal stage is the broadcasting of the message via a medium; Perceiving stage is where the receiver puts the incoming message into some form that will make it more understandable while the decoding stage is where the message is interpreted by the receiver; and the understanding stage is where the receiver gets the message as intended by the sender.

The knowledge received is then stored as procedural, declarative or conceptual knowledge. Procedural knowledge is the information that relates to action rules. This is classified according to situations and their properties. Declarative knowledge is descriptive information (Kiboss, 2000). It is knowledge that is referred to as schema, mental structures. This knowledge remains static until changed by learning. Tact knowledge is the knowledge that influences cognitive processing but the learner is not aware. Conceptual knowledge is information about the physical, social environment and material world as in the knowledge base represented in Table 1.

Table 1: Acquisition of knowledge and employment of knowledge

Acquisition of knowledge(Storage)			**Employment of knowledge (Retrieval)**		
Memory system component	Declarative knowledge	Procedural knowledge	Contextual knowledge	Cognitive complexity	Total cognitive system
Learning time	10%	20%	25%	30%	15%
Learning objectives	Verbal information	Intellectual skills	Contextual skills	Cognitive strategies	Creative process
Instructional methods	Expository strategies	Practice strategies	Problem oriented strategies	Complex problem strategies	Self-directed experience

(After Tennyson's Model 1987)

The learners create schemata by which they use to organize their perceived environment (Vosniadou, 1996). These structures are used to identify process and store incoming information. Using the process of assimilation, the individual attempts to place new concepts into existing schemata or knowledge base. When new information does not fit into existing schemata, the learner can create new ones into which the new stimulus is placed or the existing schemata is modified. However, because of the shift in focus from the traditional schooling paradigm to knowledge acquisition, emphasis on thinking skill can be developed. The process puts the learning responsibility or power more in the hands of the student than when the conventional methods are used, (Tennyson & Rasch, 1988). CBL therefore, gets an upper hand in instruction as it disseminates knowledge to learners by (1) presenting information, (2) guiding pupils during instruction, (3) providing practice to pupils and (4) providing assessment (Alessi &Trollip 1991; Walklin, 1982; Bruner 1971).

Alessi and Trollip (1991) outlined steps for presenting a lesson. They are: (a) gaining attention, (b) informing learner of lesson objective, (c) stimulating recall of prior learning, (d) presenting stimuli with distinctive features, (e) guiding learning, (f) eliciting performance, (g) providing informative feedback, (h) assessing performance, and (i) enhancing retention and learning transfer. These steps go a long with the internal events, such as alertness, expectance, and retrieval to working memory, selective perception, semantic encoding, retrieval and responding, reinforcement, cueing retrieval and generalizing in the course of the lesson to bring about learning. The CBL extends on the senses of the learners and hence facilitates their learning, perception, and motivation.

The comparison of the information processing in the mind and the computer does not imply that there is a direct comparison between thought processes and the functioning of a digital computer. The computer programme is only syntactical and minds are semantical in the sense that they have more than a formal structure; they have content (Rutkowska & Crook, 1987). Information processing by a learner involves more than the manipulation of symbols (as a computer does) but provides interpretation and meaning to the symbols.

The manner in which the learning environment is organized is also important because learners might not learn all that is taught in a single exposure of teaching. There is need to create a barrier free environment that is conducive for learning, that which accommodates the learners with physical disabilities and to employ effective approaches that will suit the nature of diverse handicapping conditions if the learners' motivation and interests are to be sustained. This entails the planning of activities which may involve the use of interactive multimedia to support learning and create collaborative groupings that are likely to encourage learners directly with instructional materials, (Gavora & Hannafin, 1995).

The new realization about the learner, which guides the theory and research, is that the learner is an active inquiring agent, (Winnie & Butler, 1994). Classifying the learner as active implies that he or she is continuously involved in cognition about self and environment. Cognitive processes are pertinent to the understanding of how human-machine interacts in a learning process, (Winnie, 1991). The mind is a biological and physical organ that does the work of information processing. It is divided into unit areas. The working memory is the metaphorical mental location where information is processed using neuropsychological properties (Heartel, *et al.*, 1981).

Classroom use of computers involves children working in-groups. The presence of a number of children interacting around a computer offers an important social dimension to educational computing. The computer acts as a stimulus for the discussion and exchange of ideas, often promoting teamwork as members of the group act collaboratively to solve a problem presented by the computer (Sewell, 1991). Davies & Selwyn, 1999) observes that computer-supported cooperative learning is largely about emphasizing social interactions as learning is not only about accumulation of knowledge but is also part of a social context in which the students live. Empirical data from researchers such as, Hung and Khine (2006) and Bollinger (1986) have documented many potential benefits of using computers in Mathematics education, an area that has presented a lot of challenges to learners particularly at the secondary school level.

The learning is context-related, as well as a process that develops through culturally related activities. What is needed is a new conception of the mind, not an information processor but a biological system that exists equally well within an individual's brain and that has in it tools, artefacts and symbolic systems used to facilitate social and cultural interaction, (Rollinson, Broadfield & Edwards, 1998). The theory reveals the presence of two levels. Mathematics is one of the science based core subjects which has existed in the secondary school curriculum for a long time and plays an integral role in education, (Government of Kenya, 2002).

It is common knowledge that Mathematics and Sciences subjects (Biology, Chemistry and Physics) are a thorn in the 'flesh' of most high school students in Kenya (Chiriswa, 2002; Kwaka, 2003). This fact is illustrated by the persistent poor performance by most of the students in the subjects. The dismal performance, according to most researchers could be attributed to have shown that few of the learners with physical disabilities perform above the grade C in their Kenya Certificate of Secondary Examination. This could be due to the fact that the curriculum has not been modified in the way it is presented to the learners with physical disabilities or in the way it is taught and examined. Disabilities may range from psychological to physical conditions and the learners with physical disabilities find it hard to find a learning facility that can fully satisfy their education needs, (Christenten, 1997).With the advent of internet, a new learning approach has come up as a perfect solution for these special group, (Ogunyi & Kiboss, 2002).

No comprehensive study had been conducted in Kenya to collate views of teachers and learners of mathematics in order to establish the relationship between the mathematics performance on one hand and the use of CBL with specific reference to the learners with physical disabilities on the other hand. This study therefore was to bring into focus the use of information and communication technology (ICT) in the teaching of mathematics with the objective of determining whether the perception of ICT potential in classroom instruction in Kenya could influence the students learning of mathematics. Computer based learning (CBL) in Kenya may be classified as instruction that does not only present information just like a book, video tape or television but also controls information during the teaching-learning process. It is interactive in that the learner interacts with the hardware, software, and the subject matter (Gavora, & Hannafin, 1995; Crawford 2000; Kiboss, 2002).

The focus of the study was on the use of CBL that is able to present lesson content and offer guidance to students in the acquisition of knowledge and skills in the classroom. The reality of learning and educational use of ICT is its perceived strength of encouraging active classroom participation between the teacher, the students and the content rather than the passive intake and rote memorization prevalent in most traditional classes, (Eraut, 1991; Fisher, 2000). This falls in line with the current theories of instruction that recommends that teaching should be related to the socio-cultural environment of the learner, (Kagan, 1990; Lerman, 1997). This brought out the need to design a collaborative CBL programme that emphasized peer interaction in the context of cooperative goals and investigated its effects on cognitive and affective domain in the learning of mathematics among the students with physical disabilities, (Johnson & Johnson, 1995; Kiboss, 2002).

Kiboss (2000), in the Journal of Information technology for Teacher Education 9(3).199-213 wrote an article on Teacher/pupil perspectives on computer-augmented physics lessons on measurement in Kenyan secondary schools. He used selected secondary schools for the non disable learners in the then Rift Valley that sampled 1200 population. Instruments used were both questionnaires and interview schedules and used only multiple regression analysis in analyzing quantitative data. Kiboss (2000) observed that cooperative learning like the use of CBL produces significantly higher achievement in sciences among secondary school students than those taught in the traditional teaching methodologies.

Alessi and Trollip, (1991) on the other hand, in their book; Computer Based Instruction Methods and Development concurs with Kiboss that using computer based learning produces significantly high performance than using traditional mode of teaching. However, these authors did not capture the effect of CBL among learners with disabilities with specific reference to Mathematics subject. In their analysis however, they did not used Pearson's r which would have clearly check on the direction of relationship, whether positive or negative, established the strength of the said relationship and guide the researcher in either accepting or rejecting the null hypothesis.

1.4 Statement of the Problem

Learners with physical disabilities are not just those on wheelchairs and those with mobility problems. The study specifically focused on those with no or weaker upper limbs due to disability. They have poor co-ordination or degenerative disorders, affecting their learning ability and reducing their degree of concentration in studies. Mathematics subject in the present 8:4:4 curriculum has been a compulsory subject and have not been offering room for adaptations in the way it is presented either as a subject or in examinations to suit the learners with physical disabled. Form three class is a crucial stage that require the students to master the concepts of the subject if they are to perform well in form four examinations and in life thereafter. However, it was the worst performed subject among the learners with PD in the Kenya Certificate of Secondary Education (KCSE) as indicated in the 2008 to 2013. The mean score in 2008 was 1.102; in 2009 it was 1.004 in 2010 it was 1.502; in 2011 it was 1.342 in 2012 it was 1.209 and 2013 it was 1.303. This was below the national average of 3.155 over the same period. The maximum expected national mean is 12.00; hence the need to determine the reasons behind this discrepancy in the mathematics performance among learners with PD. Literature exists on the effect of CBL on academic achievement of regular learners in various subjects like accounting and physics but there was still a need to look into the effect of the same on learners with physical disabilities with specific reference to mathematics subject. Therefore the research established the effects of CBL methods on mathematics performance among selected learners with physical disabilities in secondary schools in Kenya.

1.5 Purpose of the study

The purpose of this study was to establish the effects of computer based learning use on academic performance in mathematics among learners with physical disabilities in secondary schools in Kenya.

1.6 Objectives of the study

The objectives of the study were to;

i. Asses the instructional strategies used in teaching mathematics to learners with PD in secondary schools in Kenya.
ii. Determine the effects of CBL use on mathematics performance of learners with PD in Secondary schools in Kenya.
iii. Establish the challenges faced by the learners with PD in learning mathematics using CBL methods in Kenya.

1.6.1 Research Questions

The solutions of the following research questions were sought in the study.

i. What instructional strategies are used in the teaching mathematics to secondary school PD students in Kenya?
ii. What challenges do learners with PD face in learning mathematics using CBL methods?

1.6.2 Hypotheses of the study

The solutions of the following hypothesis were sought in the study.

Ho_1: There are no effects of CBL use on mathematics performance among learners with PD in Secondary schools in Kenya.

1.7 Significance of the study

Students with physical disabilities have enormous challenges in their learning. This is because the method used for instructions is mostly tailored towards regular learners. The schools invest in computers mainly for the purpose of storing records and assessment but it should also be used for instructional purposes. The Phocomelia learners will find it difficult to handle complex subjects like mathematics. Those with poor motor coordination experience the same. The use of CBL would be of use because it would make these learners manipulate difficult topics with ease by striking computer keys using head pointer instead of fingers.

The findings of the study were also expected to help the Ministry of Education and relevant stakeholders to develop a method that could improve the performance in mathematics among the learners with physical disabilities. The findings were also hoped to improve the teaching of the subject and enable the teachers develop a good learning resource for the physically disabled learners. Results of this study may initiate changes in one or more of the instructional modes in order to enhance mathematical achievement for all students. With information about the potential impact of computer-assisted instruction, institutions can invest their resources wisely. It may suggest future research into ways to transfer what is successful in residential developmental mathematics courses to improve learning among physically disabled children.

1.8 Scope of the Study

The study was carried out in the following three secondary schools for the physically handicap; Joyland secondary school in Kisumu county, Joytown Secondary School in Thika, Kiambu county and Portriez Secondary School in Mombasa county. The study sought to establish how the teaching method influenced the student's achievement in mathematics among the learners with physical disabilities in Kenya.

1.9 Limitations of the Study

The responses from the interviews were rather limited despite a lot of effort put in by the researcher to ensure that all the necessary information was captured. However, this did not affect the output much because the questionnaires took care of most issues. The number of schools with learners who are physically disabled in Kenya were few and all of them were involved in the study. Therefore no simple random sampling was conducted.

1.10 Theoretical Framework

The theoretical framework of the study was based on B.F. Skinner's 'black box' theory and programmed instruction. B.F. Skinner's viewpoint is based on a definition of learning as an observable change in behaviour (Skinner, 1950). The potential of the computer as a teaching aid promises increasing design sophistication. Computers can be programmed to judge student input and to tailor lessons to each individual's level of mastery. In a tutorial mode, computers can present instructional input and require mastery of each step in ways that were not possible with the early machines. The sensitivity of the instructional designer to alternative patterns of student learning is the necessary key to full use of a computer capacity. Simulation-using the computer to model a real situation—enables even greater sophistication, allowing realistic reactions to student input. Well-designed intellectual games can provide pertinent environments in which to practice important problem-solving skills.

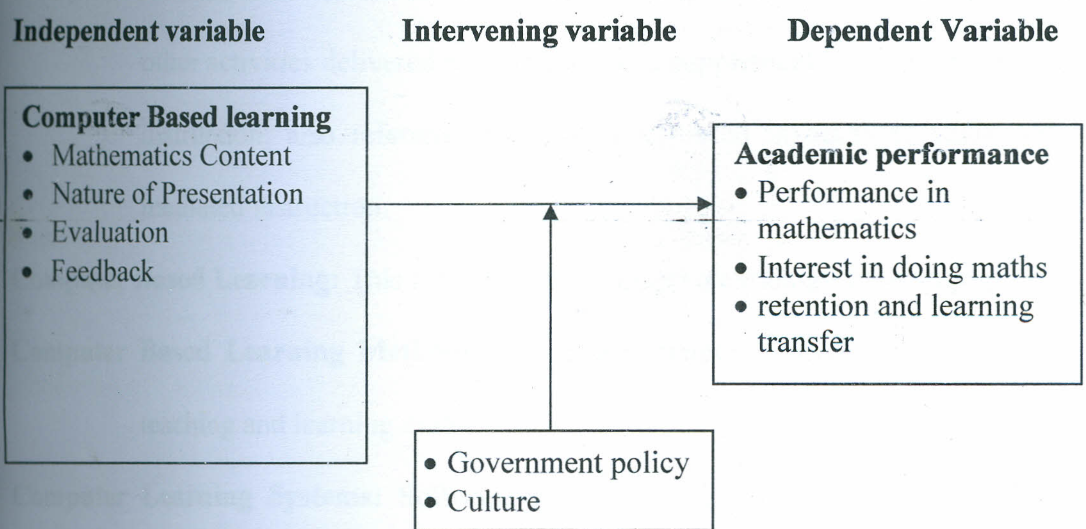
The relevance of this theory is that the learning process is based on the principle of reinforcement and that the stimulus-response schema is based on the operant conditioning whereby an entirely new behaviour is learnt to a familiar stimulus that is, computer instruction is equated to the conditioning of a desired behaviour. The classroom is equated to the 'black box', with the computer as the device to be clicked by the student to give desired behaviour of positive results from the learning process. This means that CBL, has to present a stimulus, give feedback to the student's response (to the stimulus) and reinforces desired responses. The behaviour to be learnt has to be split up in small components (computer tasks) which are presented to the student. The desired behaviour is reinforced through repetitions by the computer since it can go over and over a given concept several times based on the student's responses.

Skinner's (1950) concept of programmed instruction emphasized the need for total educational plan involving identifying objectives; arranging subject matter into logical sequences; preparing and testing instructional programs; and then implementing, testing, and revising them. Skinner shifted the emphasis in education away from the teacher's presentation of information and toward the learner's behaviour and, especially, reinforcement of that behaviour. His teaching machines provided programmed instruction, which allowed students to proceed through lessons by small steps, at their own pace, following an orderly sequence, and receiving immediate reinforcement for every correct response.

Skinner's work emphasized the use of audio-visuals, which are well-illustrated in facilitating individualized learning. This is the concept that computer use in the teaching and learning of Mathematics was hoped, would bring to the Kenyan classroom sessions. This theoretical framework is therefore acting as a point of reference in establishing the use of computers as a medium of teaching and learning Mathematics education to learners with PD in Kenya.

1.11 Conceptual Framework

The conceptual framework adopted was from Winnie and Butter, (1994) a model which was modified and adapted to suit this study. The model identified three variables; Independent variables (characteristics of instructional tasks), the Dependent variables (learner) and Intervening variables (events that affect learning). Information processing gives an explanation on how the role of the teacher in combination with the CBL changes from that of purveyor of knowledge to that of manager of learning. This means that the prescriptive, one-way teaching, which transmits knowledge and skills, must give way to active learning where the learner builds his or her knowledge. From the framework, the independent variable is CBL while the dependent variable is academic performance.



Source: Adopted from Winnie and Butter, (1994).

Figure 1: Conceptual framework of Instructional Information Processing for CBL and TI methods in Mathematics.

The model indicates that CBL disseminates knowledge to learners by; presenting information, guiding students during instruction, providing practice to students and providing assessment.

This has direct influence of mathematical performance among the learners with PD because CBL enables gaining of attention, informs learners of lesson objective, stimulates recall of prior learning, presents stimuli with distinctive features, guides learning, elicits performance, provides informative feedback, and enhances retention and learning transfer.

1.12 Operational Definition of Terms

CAST: Computer Assisted Statistics Text. It is dynamic mathematics software that joins geometry, algebra and calculus provides three different views of mathematical objects.

Computer Assisted Instruction: Refers to tutorials, drill-and-practice, graded assignments, and other activities delivered by computer as a supplement to traditional teacher-directed instruction; also referred to as computer-based instruction (CBI) and computer-mediated instruction.

Computer Based Learning: This is the use of computer technology for learning.

Computer Based Learning Methods: These are computer technology approaches used for teaching and learning mathematics.

Computer Learning Systems: Software provided by textbook publishers to complement a textbook. The software includes features such as homework, quizzes, tests, tutorials, videos, and online tutoring.

Computer-Mediated Instruction: Refers to a thorough explanation of concepts using interactive multimedia software, which usually includes activities requiring student interaction imbedded in the instruction, online assessment with immediate feedback, and course management features to track student progress. The software uses text, graphics, sound, animation, video, and pictures to present information.

Degenerative Disorders: Condition where the upper limbs (hands), though they appear normal are so weak due to disorder of the muscles and/or bones to the extend that they cannot perform the required functions adequately without external aid.

Geogebra: This is a computer soft ware for teaching and learning resources in mathematics. It is dynamic mathematics software that joins geometry, algebra and calculus. It provides three different views of mathematical objects: *a Graphics View*, *a Numeric Algebra View* and *a Spreadsheet View*.

Graphics View: This is the using of the construction tools available in the tool bar to do geometric constructions with the help of mouse.

Information Processing: This is the reducing information from the outer world analyzing and interpreting and giving a feed back by a learner.

Mathematics: This is the subject that deals with addition, subtraction, multiplication and division of numbers.

Mathematics Achievement: For the purpose of this study, mathematics achievement will be defined as the score on the posttest, which is the final exam.

Mathematical performance: Refers to the score obtained by the students in the final exam.

Numeric Algebra View: This is where the mathematical objects are organized as *free b*and *dependent objects*. If a new object is created without using any other existing objects, it is classified as a free object. If a newly created object was created by using other existing objects, it is classified as a dependent object.

Paraplegia- Physically disabled condition where both the hind and the front legs are missing.

Physically disabled -It is a condition where the learners' limbs are so affected that they cannot be able to use them effectively in learning without external aid or adaptations.

Traditional Instruction: Face-to-face instruction delivered by a teacher dispensing knowledge and demonstrating skills using lectures sometimes integrated with discussion and group work.

Traditional Methods of Teaching: It is any teaching methodology used by the teacher apart from computer based learning.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The use of computer technology to supplement traditional instruction and to deliver instruction to mathematics students is a recent development. Although considerable research indicates that computer based instruction can have a positive impact on learning for students of all ages and in a variety of content areas, the research is limited and inconclusive for students with PD in learning mathematics. Some researchers think that CBL has great potential for improving developmental education. Others contend, however, that developmental students need personal interaction with an instructor and other students, (Kinney & Robertson, 2003).

Teaching methods is the subject of many research papers in trying to evaluate methods that can improve students' ability to interactively be involved in a class. This seems to be particularly necessary in the current Internet wireless connectivity environment where students can be interacted through having or using those tools. Through providing the ability for students to use those tools in their education besides using them for entertainment or social activities, this may have positive impact on education. The literature reviewed on Computer use in teaching and learning mathematics in secondary schools, instructional strategies for teaching mathematics to learners with PD, effects of CBL on mathematics achievement of learners with PD and challenges faced by learners with PD while using computers and suggested strategies that can be used to counteract the named challenges.

2.2 Computer use in teaching and learning mathematics in secondary schools

According to Dwyer and Margot (1975) in a report about 'project solo' – a project about people involved in computer learning carried out between 1970 and 1977, elaborate experimentation with various modes of using computers in high schools was carried out and computer-related curriculum modules for secondary schools developed. The project which was jointly supported by the National Science Foundation and the University of Pittsburgh focused upon computer-augmented learning in secondary schools, engineering and other fields. The primary objective of the project was to stimulate students to analyse, synthesize, evaluate and apply Mathematics on their own by using algorithmic problem solving and student-controlled computing as catalysts (Scardamalia, 2004). The more than 100 computer-augmented, curriculum modules produced by the project are designed to help high school students use a computer as a tool in exploring concepts and principles from topics in high school Mathematics (Hung and Khine, 2006).

A computer resource book for algebra, which was authored by Dwyer, who was the director of project solo and Margot a researcher with the project, illustrates how the ideas for teaching and learning Mathematics emanating from project solo can be used in high schools in Kenya that have access to computers (Hung and Khine, 2006). Many current students lack investigation and exploration skills (Oduor, 2009). The capabilities of computers to assist students discover and conjecture is obvious (Bhagwan, 2005). Computers provide instant calculations and rapidly generate graphics with which students can make and test conjectures. Many Mathematical software packages are open-ended tools, adaptable to a range of learning and teaching needs and objectives (Hung & Khine, 2006).

Software are available that can solve most of the exercises in today's Mathematics textbooks (Bhagwan, 2005). The widespread availability and use of Mathematical manipulation software has resulted in significant changes in emphasis and paradigms used in school Mathematics. Bollinger (1986) concluded that 75% of all problems in high school algebra could be solved completely or partially by symbolic manipulation software. In his research findings, he asserts that students learn more Mathematics in less time with broader conceptual understanding using symbolic-manipulation software than from traditional instruction. Proper use of symbolic manipulation software with application problems would change the focus of instruction and assist students through a conceptual and applied understanding of real-world mathematics (Garrison and Anderson, 2003).

According to Deepark and Turner (2006), teachers must feel comfortable using computer technology and have an awareness of applications and how computers can be effectively integrated into learning situations. The use of computer technology in Mathematics teaching and learning, they suggest, should be a commonplace to teachers as using the chalkboard and overhead projector. This is due to the fact that technological aids allow greater realism in classroom, which in turn calls for re-examining the content of teaching and learning of Mathematics. Further, according to Nievergelt, (1986) in Hung and Khine (2006); the appearance of microcomputers has initiated graphic animation and implementation of an increased variety of instructional strategies, such as simulation and modelling. Significant CAL projects emerging from these efforts in the early 1970's included the PLATO III and IV (Programmed Logic for Automatic Teaching operations).

Eshiwani (1981) list the aims of school Mathematics for East African countries as to: develop Mathematical skills and understanding of number patterns shapes, together with social, domestic and commercial applications; instill into the students deductive and critical methods of thinking that lead to intellectual independence; train students in generalization and lead to an improved and more accurate way of communication both in language of instruction together with scientific terminologies. However in elaborating on mechanisms of achieving the aims, he falls short of pointing out how accurate communication both in language of instruction together with scientific terminologies would be achieved. It is the contention of other scholars that these aims are progressively acquired and it is only through positive reinforcements by using computers in Mathematics teaching/learning among other instructional tools that the teacher can confirm success in his/her instruction (Omwenga, 2005). This link would be achieved probably better with the use of computers as a medium of teaching and learning mathematics.

Kwaka (2003) in his research findings on the influence of teachers' assessment in enhancing improved performance in Mathematics among secondary school students' in Mombasa District, noted that student's response to the tasks is subjected to specific prescribed objectives. The student's response to the tasks is subjected to a scoring or classificatory procedure by the assessor and hence makes a reference about the pupil. He further explains that when appropriate feedback is given, assessment should provide learners, assessors and educators with insights about themselves. However, Kwaka does not point out the appropriate feedback for better assessment. A computer in its operations gives accurate, instant, visual and audio congratulatory feedback to the learner enabling the learners, assessors and educators to have a clear insight about them when used.

Still on assessment and reinforcement, Bloomfield (1975) describes continuous assessment as a systematic collection of marks over a period of time and their aggregation into a final grade. In this mode, marks are awarded for class work, homework, practical work, oral or/and project work. However all the marks awarded are kept by the teacher for end term analysis. In contrast, instant feedback for every activity done by the student makes meaningful reinforcement. With computers in place, all assessments would be instantly awarded, stored, and retrieved by the student for instant motivation. Kieren (1973) records evidence reported from scores of studies designed to examine the effectiveness of computer-augmented teaching and learning. The data indicates that computers can be used very effectively to enhance the learning since its readily retrievable data is a major source of reinforcement.

Ayot (1984) in, Language For Learning; which stated that, out of all that we hear and see, we learn only 10% through the senses of hearing and 80% or more through the sense of sight; we retain 20% of all that we hear and 50% of what we see and learn. Therefore; the use of computers in mathematics classrooms will ensure that students will be able to learn more through observing the computer screen and retain more from what they will learn since the visual stimulus has a more lasting impact particularly in learning. This is in line with a common proverb today which says that ''what I hear I forget, What I see I remember and What I do I know''.

Esmond (2011), in his publication in the daily Nation asserts that, one way of instilling computer skills are to adopt basic computer education in schools; teaching of computer skills in schools allows youngsters to come to terms with the use of ICTs in modern life. An enlightened young generation can put its technical skills and talents in transforming the way we apply ICT. Esmond (2011) further continues to inform that in a bid to set the pace for young people's initiation into the digital world, the government of Kenya allocated Ksh 680 million in 2011 budget for the purchase of computers for schools.

Finance minister's allocation of Ksh 680 million for schools was a good start in scaling the needs for ICT in primary and secondary schools as recommended by SMASSE which is a national programme for secondary schools mandated to strengthen mathematics and science subjects with emphasis in the use of computer technology (Esmond, 2011). In all these discussions by these authors, CBL use is seen to be filling the gaps associated with the use of TI among the able bodied learners. Its use among the learners with PD would therefore bridge the glaring gap associated with dismal performance in mathematics among these learners in secondary schools are greated on little is captured

2.2.1 Trends of using Computer in teaching and learning mathematics Globally

Audio-Visuals (A-V) are aids that demand the use of touching, listening or sight. Results from empirical study shows that people learn, 83% through sight, 11% through sound, 3.5% through smell, 1.5% through touch and 1% through taste (Mondoh, 2005). The use of computers in Mathematics instruction therefore combines sight, sound and touch components totalling to 88% giving the learner an upper hand. In the mid-1950s and early 1960s collaboration between educators at Stanford University in California and International Business Machines Corporation (IBM) introduced CAI into select elementary schools in USA (Smith, Stanley, Sherwood and Bruce, 1976).

Initially, CAI programs were a linear presentation of information with drill and practice sessions. The early CAI systems were limited by the expense and the difficulty of obtaining, maintaining, and using the computers that were available at that time. Programmed Logic for Automatic Teaching Operations (PLATO) system, another early CAI system initiated at the University of Illinois in the early 1960s and developed by Control Data Corporation, was used for higher learning (Sherwin, 1978). It consisted of a mainframe computer that supported up to 1000 terminals for use by individual students. According to Sherwin (1978), it was estimated that over 100 PLATO systems would be operating in the United States by 1985.

PLATO also introduced a communication system between students that was a forerunner of modern electronic mail (messages electronically passed from computer to computer). The Time-shared Interactive Computer-Controlled Information Television (TICCIT) system was a CAI project developed by Mitre Corporation and Brigham Young University in Utah (Smith *et al.*,, 1976). Based on personal computer and television technology, TICCIT was used in the early 1970s to teach freshman-level mathematics and English courses. With the advent of cheaper and more powerful personal computers in the 1980s, use of CAI increased dramatically. In 1980 only 5% of elementary school and 20% of secondary schools in the United States had computers for assisting instruction (Small, David & Sandy, 1984). Three years later, both numbers had roughly quadrupled, and by the end of the decade, nearly all schools in the United States, and most industrialized countries, were equipped with teaching computers.

A recent development with far ranging implications for CAI is the vast expansion of the Internet, a consortium of interlinked computers (Deepark and Turner, 2006). By connecting millions of computers worldwide, these networks enable students to access huge stores of information, which greatly enhances their research capabilities (Bhagwan, 2005). Schools are also working to incorporate computers into classrooms. The need for computer literacy in the 21st century has put an additional strain on school budgets and local resources (Deepark and Turner, 2006). Schools have struggled to catch up by providing computer equipment and instruction and by making Internet connections available. Apple Computer, Inc. in the USA has provided computer equipment to help schools meet their students' computer-education needs.

New York City school system in the USA initiated the first full-scale operational computer-system designed by Radio Corporation of America (RCA) to teach large numbers of pupils on a simultaneous and individual basis (NCTM, 2000). The computer-based instructional system (CBIS) is capable of teaching and reading Mathematics at elementary school level. Using the system, as many as 192 students may proceed with their computer lessons simultaneously. In the initial stages, approximately 6,000 children in 16 schools were involved in the project. Located within each school is a communications unit that connects with an RCA Spectra 70-45 computer situated in Manhattan, USA.

The student identifies himself to the computer by typing his name on the terminal keyboard. He then receives anywhere from 5 to 20 minutes of instruction (Carrington, 1993; NCTM, 2000). The computer acts as a private tutor, giving immediate reinforcement of correct responses and rejecting all mistakes. Statistics regarding each student's progress are compiled on a battery of magnetic tapes that are automatically updated to include the latest student-computer interchange. The teacher may then ask the computer for reports on his students.

An increasing number of school libraries have computer labs with computer workstations, software, and Internet connections (Mahapatra, 2005). Because school libraries often emphasize the variety of media in their collections, they are sometimes referred to as library media centers. Most school libraries further enhance their collections by becoming members of school library networks; this allows them to share resources with libraries in other schools (Crook, 2005). As part of the mathematics reforms of the National Council of Teachers of Mathematics (NCTM) of North America and the Advisory Task Force of the Caribbean Community (Caricom), it is required that students be able to learn and use Computer Technology(CT) as an integral part of the learning of mathematics (Carrington, 1993; NCTM, 2000).

Some countries or islands in the Caribbean such as Cuba, Jamaica, Haiti and the Bahamas have been providing their teachers with computer literacy skills and integrating CT in various subject areas (Carrington, 1993; Miller, 1996). However, this innovation is not common in mathematics classrooms. According to (Clarke, 2007), integration of Computer Technology (CT) in the Caribbean countries of Cuba, Jamaica, Haiti and the Bahamas had to be strategic and practical because of its economic situation. Mathematics computer software programs, the graphing calculator (GC) and the internet were becoming more commonly used among different Caribbean countries of Cuba, Jamaica, Haiti and the Bahamas (Arnold, 2007).

In some Caribbean contexts, however, these tools were not frequently used or were not always accessible to teachers and students in Mathematics classrooms (NCTM, 1991). Selecting computer Mathematics software such as Math Trek was important in that it had to be interactive and motivating towards learning mathematics (Pokay & Tayeh, 1997). This phenomenon was common for all software programs within learning environments.

Pokay and Tayeh, (1997) found Math Trek for grades 7, 8, & 9 (MT789) to be useful in motivating and engaging students in classrooms; students' interaction has been empowering for each other and the teachers had opportunities to facilitate active learning and inquiry. The graphing calculator (GC), a commonly used tool in secondary school Mathematics(Wilson & Krapfl, 1994), has been found to have potential benefits for students' understanding of functions; it is further stated that the GC has the potential for influencing the way mathematics is taught and learned, which in turn would affect the students' achievement, and their mathematical disposition.

In Hong Kong, according to Education and Manpower Bureau (EMB, 1998), the special administrative region government's five year plan on ICT implementation in schools was launched in late 1998. EMB, (1998) adds that this five year plan is within education reforms that aim to develop students' capacities for self-learning, problem solving, information seeking and analysis, critical thinking as well as the ability to communicate, collaborate and learn.

A survey of ICT and education in Africa, Farrell (2007) found that there was a great deal of variance in ICT policies for education among the 53 African countries surveyed. South Africa clearly is unique in terms of being able to move its ICT agenda forward. Those countries that are steadily moving to sustainable economies (Mauritius, Ghana and Botswana for example) constitute another group making remarkable progress (Karanja, 2011). Mutula (2003) identified the ICT constraints as high cost of access to telecommunications, government policy towards ICT, underutilization of existing technologies, limited indigenous base and digital illiteracy.

Checkpoint (2008) pointed out that Kenya has become the third African country to launch E-learning facilities in secondary schools after South Africa and Nigeria. In its article, Checkpoint states that the program aims to replace the blackboard with touch screen and students to send their work to teachers through wireless connectivity. However rolling of this program may not be effective in rural areas since they lack the basic infrastructure to enhance this type of learning.

2.2.2 Computer Programs that Support the Teaching and Learning of Mathematics

A computer is an easy aid to use and one does not need to possess any technical expertise to use it (Ball, 1986). Computers have inbuilt well written programs that supports the user by providing information on what options are available and helps should the user go astray. Sherwin (1978) asserted that there are computer programs that can be used in connection with exposition by the teacher in the teaching and learning of Mathematics including; COUNTER- is a program which exploits one very simple idea; it counts on the computer's screen. When it starts, COUNTER is ready to begin counting in the usual way 1, 2, 3, 4, …….and it displays each number on the screen using large characters. It has an option of listening to counting as well as watching it. AIRTEMP – is a program which is used to draw by giving a simple illustration of what the computer has to offer in terms of visual aid that can be used by a teacher to explain bar graphs and line graphs.

LOCUS – is a program that draws loci and geometrical constructions. SINCOS –Is a program providing a model that helps explain the meaning of the sines and cosines of all angles, positive and negative. When the program starts, a circle with horizontal radius is displayed, if the user enters and angle say 450, the radius rotates slowly until it reaches 450 (Wilson & Krapfl, 1994). Programs that offer games or pose problems include; BLOCKS – is a program about arithmetic whereby the computer simulates the throwing of three dice, and the numbers shown on the dice are displayed at the bottom of the screen; others include MATHLAP and MATHEMATICA. Programs that support mathematical investigation include; DIAGONAL –Is a program that concerned with exploration of the diagonals of rectangles (Zammit, 1992).

Programs that draw pictures according to (Howe and Ross, 1981), include; BUILD – Enables the user to draw a picture composed of cubes, CALDRAW – Draws all geometrical objects. Some of the Programs already in use in primary schools in Kenya include; TOPGRADES – a program designed by David Timm in the United Kingdom 15years ago (Esmond, 2011).This program according to the author is now fully used in Kenyan primary schools such as Rusinga Schools, Makini School, Braeside School, Bahati and Mukumu primary in western Kenya(Esmond, 2011).

Karanja (2013), on using technology to support conceptual teaching and learning of mathematics and science; Kenyatta university's department of Communications and technology flanked by Dr. Kiio *et al.*, handed over graphic calculators, science probe kits and PC tablets from Hewlett-Packard (HP) catalyst initiative Project, to Kenya High and Nairobi school mathematics and science teachers as a step to ensure use of computers in teaching and learning of Mathematics in secondary schools in Kenya.

2.2.3 Potential Benefits of using Computer (CBL) in teaching and learning mathematics

According to Deepark and Turner (2006), CBL can be adapted to the Mathematical abilities and preferences of the individual student and increase the amount of personalized instruction a student receives. Many students are said to benefit from the immediate responsiveness of computer interactions and appreciate the self-paced and private Mathematical learning environment (Crook, 2005). Moreover, computer-learning experiences often engage interest of students, motivating them to learn Mathematics and increasing independence and personal responsibility for education. Although it is difficult to assess the effectiveness of any educational system, researchers such as Hazewinkel & Michiel (2001), have reported that CAI is successful in raising examination scores, improving student attitudes, and lowering the amount of time required to master certain material. While study results vary greatly, there is substantial evidence that CAI can enhance learning of Mathematics at all educational levels.

Hazewinkel and Michiel (2001) further asserts that 'The guided drill' is a computer program that poses mathematical questions to students, returns feedback, and selects additional questions based on the students' responses. Computers also can help students visualize objects that are difficult or impossible to view. For example, computers can be used to display three dimensional objects/ models, graphical presentation, histograms, pie charts and bar graphs more conceptually (Arnold, 2007). Computers can also be used in problem solving, which involves visualizing, imagining and manipulating, analyzing, abstracting and associating ideas (Siddiqui, 2004). Problem solving often requires skill in reading as well as computing and ability to state associations (Orton, 1994). The main step in problem solving is in the use of the computer as a search model to solve the problem, such as performing computations involved in completing the deductive proof, finding the solution set for the equations or inequalities, checking answers to see whether the results satisfy the conditions given and stating the complete answer to the problem (Weiss, 2006).

2.3 Effective Mathematics strategies for instructing Students with Physical disabilities

All learning requires the use of strategies. Because math works with both the concrete and abstract, specific tactics may be necessary for understanding and succeeding in a math classroom. Math strategies are methods used to solve problems in math. Students sometimes come about these naturally, but many are taught by teachers. For some students, such as those with special needs, specific strategies are necessary. There are effective math instruction strategies for students with disabilities, especially students who have PD.

There have been five meta-analyses on the subject, reviewing a total of 183 research studies (Adams & Carnine, 2003; Baker, Gersten, & Lee, 2002; Browder, Spooner, Ahlgrim-Delzell, Harris, & Wakeman, 2008; Kroesbergen & Van Luit, 2003; Xin & Jitendra, 1999). The studies combined in these meta-analyses involved students with a variety of disabilities—most notably, PD and LD, but other disabilities as well, including mild intellectual disabilities, AD/HD and behavioral disorders. The meta-analyses found strong evidence of instructional approaches that appear to help students with disabilities improve their math achievement. The National Mathematics Advisory Panel Report, (2008) investigated successful mathematical teaching strategies and provided additional support for the research results. According to these studies, four methods of instruction show the most promising results.

These are: **Systematic,** detailed instructional approaches in which teachers guide students through a defined instructional sequence. Within systematic and explicit instruction, students learn to regularly apply strategies that effective learners use as a fundamental part of mastering concepts; **Self-instruction,** through which students learn to manage their own learning with specific prompting or solution-oriented questions; **Peer tutoring,** which is an approach that involves pairing students together to learn or practice an academic task and Visual representation, which uses manipulative, pictures, number lines, and graphs of functions and relationships to teach mathematical concepts. In order, to make use of this information, an educator would need to know much more about each approach.

In Kenya according to Kenya Institute of Special needs Education module, (2008), the teaching and learning strategies for learners with special needs included; task analysis, team teaching, co-operative teaching, group teaching, direct instruction, individualized educational programme and collaborative teaching. All these strategies are intended to enhance the teaching and learning of mathematics among the learners with PD in secondary schools in Kenya.

2.3.1 Explicit and Systematic Instruction

Explicit instruction, often called direct instruction, refers to an instructional practice that carefully constructs interactions between students and their teacher. Teachers clearly state a teaching objective and follow a defined instructional sequence. They assess how much students already know on the subject and tailor subsequent instruction, based upon that initial evaluation of student skills. Students move through the curriculum, both individually and in groups, repeatedly practicing skills at a pace determined by the teacher's understanding of student needs and progress (Swanson, 2001). Explicit instruction has been found to be especially successful when a child has problems with a specific or isolated skill (Kroesbergen & Van Luit, 2003).

The center for applied special technology offers a helpful snapshot of an explicit instructional episode (Hall, 2002). Consistent communication between teacher and student creates the foundation for the instructional process. Instructional episodes involve pacing a lesson appropriately, allowing adequate processing and feedback time, encouraging frequent student responses, and listening and monitoring throughout a lesson. Systematic instruction focuses on teaching students how to learn by giving them the tools and techniques that efficient learners use to understand and learn new material or skills.

Systematic instruction, sometimes called "strategy instruction," refers to the strategies students learn that help them integrate new information with what is already known in a way that makes sense and be able to recall the information or skill later, even in a different situation or place. Typically, teachers' model strategy use for students, including thinking aloud through the problem-solving process, so students can see when and how to use a particular strategy and what they can gain by doing so. Systematic instruction is particularly helpful in strengthening essential skills such as organization and attention, and often includes:

- Memory devices, to help students remember the strategy (e.g., a first-letter mnemonic created by forming a word from the beginning letters of other words);
- Strategy steps stated in everyday language and beginning with action verbs (e.g., read the problem carefully);
- Strategy steps stated in the order in which they are to be used (e.g., students are cued to read the word problem carefully before trying to solving the problem);
- Strategy steps that prompt students to use cognitive abilities (e.g., the critical steps needed in solving a problem) (Lenz, Ellis, & Scanlon, 1996).

All students can benefit from a systematic approach to instruction, not just those with disabilities. That's why many of the textbooks being published today include overt systematic approaches to instruction in their explanations and learning activities. It's also why NICHCY's first *Evidence for Education* was devoted to the power of strategy instruction. The research into systematic and explicit instruction is clear—the approaches taken together positively impact student learning (Swanson, in press). The National Mathematics Advisory Panel Report (2008) found that explicit instruction was primarily effective for computation (i.e., basic math operations), but not as effective for higher order problem solving. That being understood, meta-analyses and research reviews by Swanson (1999, 2001) and Swanson and Hoskyn (1998) assert that breaking down instruction into steps, working in small groups, questioning students directly, and promoting ongoing practice and feedback seem to have greater impact when combined with systematic "strategies."

Within this example, the relationship between explicit and systematic instruction becomes clear. The teacher is leading the instructional process through continually checking in demonstration, and scaffolding/extending ideas as students build understanding. She uses specific strategies involving prompts that remind students the value of the coins, simply stated action verbs, and metacognitive cues that ask students to monitor their money. Montague (2007) suggests, "*The instructional method underlying cognitive strategy instruction is explicit instruction.*"

2.3.2 Self-Instruction

Self-instruction refers to a variety of self-regulation strategies that students can use to manage themselves as learners and direct their own behavior, including their attention (Graham, Harris, & Reid, 1992). Learning is essentially broken down into elements that contribute to success: setting goals, keeping on task, checking your work as you go, remembering to use a specific strategy, monitoring your own progress, being alert to confusion or distraction and taking corrective action, checking your answer to make sure it makes sense and that the math calculations were correctly done. Whenever students discuss the nature of learning in this way, they develop both a detailed picture of themselves as learners (known as Meta cognitive awareness) and the self-regulation skills that good learners use to manage and take charge of the learning process.

To teach students to "talk to themselves" while learning new information, solving a math problem, or completing a task, teachers first model self-instruction aloud. They take a task and think aloud while working through it, crafting a monologue that overtly includes the mental behaviors associated with effective learning: goal-setting, self-monitoring, self-questioning, and self-checking. Montague (2007) suggests that both correct and incorrect problem-solving behaviors be modeled.

Modeling of correct behaviors helps students understand how good problem solvers use the processes and strategies appropriately. Modeling of incorrect behaviors allows students to learn how to use self-regulation strategies to monitor their performance and locate and correct errors. Self-regulation strategies are learned and practiced in the actual context of problem solving. When students learn the modeling routine, they then can exchange places with the teacher and become models for their peers. The self-statements that students use to talk themselves through the problem-solving process are actually prompting students to use a range of strategies and to recognize that certain strategies need to be deployed at certain times (e.g., self-evaluation when you're done, to check your work).

Because learning is a very personal experience, it's important that teachers and students work together to generate self-statements that are not only appropriate to the math tasks at hand but also to individual students. Instruction also needs to include frequent opportunities to practice their use, with feedback (Graham *et al.,*, 1992) until students have internalized the process.

2.3.3 Peer Tutoring

Peer tutoring is a term that's been used to describe a wide array of tutoring arrangements, but most of the research on its success refers to students working in pairs to help one another learn material or practice an academic task. Peer tutoring works best when students of different ability levels work together (Kunsch, Jitendra, &Sood, 2007). During a peer tutoring assignment, it is common for the teacher to have students switch roles partway through, so the tutor becomes the tutee. Since explaining a concept to another person helps extend one's own learning, this practice gives both students the opportunity to better understand the material being studied.

Research has also shown that a variety of peer-tutoring programs are effective in teaching mathematics, including Classwide Peer Tutoring (CWPT), Peer-Assisted Learning Strategies (PALS), and Reciprocal Peer Tutoring (RPT) (Barley *et al.,*, 2002). Successful peer-tutoring approaches may involve the use of different materials, reward systems, and reinforcement procedures, but at their core they share the following characteristics (Barley *et al.,* 2002):

- The teacher trains the students to act both as tutors and tutees, so they are prepared to tutor, and receive tutoring from, their peers. Before engaging in a peer-tutoring program, students need to understand how the peer- tutoring process works and what is expected of them in each role.
- Peer-tutoring programs benefit from using highly structured activities. Structured activities may include teacher-prepared materials and lessons (as in Classwide Peer

Tutoring) or structured teaching routines that students follow when it is their turn to be the teacher (as in Reciprocal Peer Tutoring).

- Materials used for the lesson (e.g., flashcards, worksheets, manipulatives, and assessment materials) should be provided to the students. Students engaging in peer tutoring require the same materials to teach each other as a teacher would use for the lesson.
- Continual monitoring and feedback from the teacher help students engaged in peer tutoring stay focused on the lesson and improve their tutoring and learning skills.

Finally, there is mounting research evidence to suggest that, while low-achieving students may receive moderate benefits from peer tutoring, effects for students specifically identified with LD may be less noticeable unless care is taken to pair these students with a more proficient peer who can model and guide learning objectives (Kunsch, Jitendra, &Sood, 2007).

2.3.4 Visual Representations

Mathematics instruction is a complex process that attempts to make abstract concepts tangible, difficult ideas understandable and multifaceted problems solvable. Visual representations bring research-based options, tools, and alternatives to bear in meeting the instructional challenge of mathematics education (Gersten *et al.*, 2008).

Visual representations, broadly defined, can include manipulatives, pictures, number lines, and graphs of functions and relationships. "Representation approaches to solving mathematical problems include pictorial (e.g., diagramming); concrete (e.g., manipulatives); verbal (linguistic training); and mapping instruction (schema-based)" (Xin&Jitendra, 1999, p. 211). Research has explored the ways in which visual representations can be used in solving story problems (Walker & Poteet, 1989); learning basic math skills such as addition, subtraction, multiplication, and division (Manalo, Bunnell, & Stillman, 2000); and mastering fractions (Butler, Miller, Crehan, Babbitt, & Pierce, 2003) and algebra (Witzel, Mercer, & Miller, 2003).

Concrete-Representational-Abstract (CRA) techniques are probably the most common example of mathematics instruction incorporating visual representations. The CRA technique actually refers to a simple concept that has proven to be a very effective method of teaching math to students with disabilities (Butler *et al.*, 2003; Morin & Miller, 1998). CRA is a three-part instructional strategy in which the teacher first uses *concrete* materials (such as colored chips, base-ten blocks, geometric figures, pattern blocks, or unifix cubes) to model the mathematical concept to be learned, then demonstrates the concept in *representational* terms (such as drawing pictures), and finally in *abstract* or *symbolic* terms (such as numbers, notation, or mathematical symbols).

During a fraction lesson using CRA techniques, for example, the teacher might first show the students plastic pie pieces, and explain that, when the circle is split into 4 pieces, each of those pieces is ¼ of the whole, and when a circle is split into 8 pieces, each piece is ⅛ of the whole. After seeing the teacher demonstrate fraction concepts using concrete manipulatives, students would then be given plastic circles split into equal pieces and asked what portion of the whole one section of that circle would be. By holding the objects in their hands and working with them concretely, students are actually building a *mental* image of the reality being explored physically.

After introducing the concept of fractions with concrete manipulatives, the teacher would model the concept in *representational* terms, either by drawing pictures or by giving students a worksheet of unfilled-in circles split into different fractions and asking students to shade in segments to show the fraction of the circle the teacher names. In the final stage of the CRA technique, the teacher demonstrates how fractions are written using abstract terms such as numbers and symbols (e.g., ¼ or ½). The teacher would explain what the numerator and denominator are and allow students to practice writing different fractions on their own.

As Access Center (2004) points out, CRA works well with individual students, in small groups, and with an entire class. It's also appropriate at both the elementary and secondary levels. The National Council of Teachers of Mathematics (NCTM) recommends that, when using CRA, teachers make sure that students understand what has been taught at each step before moving instruction to the next stage (Berkas& Pattison, 2007). In some cases, students may need to continue using manipulatives in the representational and abstract stages, as a way of demonstrating understanding.

A major challenge of mathematics teaching for teachers is to find the combination of instructional approaches and materials that will best meet the needs of the diversity of students in their classrooms. Explicit systematic instruction typically entails teachers explaining and demonstrating specific strategies, and allowing students many opportunities to ask and answer questions and to think aloud about the decisions they make while solving problems. It also entails careful sequencing of problems by the teacher or through instructional materials to highlight critical features.

More recent forms of explicit systematic instruction have been developed with applications for these students. These developments reflect the infusion of research findings from cognitive psychology, with particular emphasis on automaticity and enhanced problem representation. This analysis of the body of research indicated that explicit methods of instruction are consistently and significantly effective with students with learning disabilities in the performance of computations, solving word problems, and solving problems that require the application of mathematics to novel situations. Only a small number of studies were located that investigated the use of visual representations or student "think a louds." Therefore, no inferences about their effectiveness can be drawn. The research suggests that they are most useful when they are integrated with explicit instruction.

2.4 Effects of Computer based learning (CBL) on Mathematics Performance among Learners with Physical Disabilities

As Philips, (1984) suggests, discovering the appropriate uses for the computer in education has been a problem. Trends in computer software show that the most promising current use of computers in education include: drill and practice to master basics skills; development of writing skills; problem solving, among others, (Gagne, 1987).There now seems to be consensus that the computer can best be used in classroom to help students develop information handling and problem solving skills in the subject like mathematics. When people think of students with physical disabilities, they tend to just think of children in wheelchairs and those who have problems with mobility. Some children have problems with manipulation due to painful joints, poor co-ordination or degenerative conditions. Information and communications technology (ICT) can support learners with physical disabilities by enabling them to access the curriculum alongside their peers. It is particularly helpful for learners who find it difficult to record their schoolwork using conventional methods, (Philips, 1984).

Mathematics education is a leading agent in the establishment and foundation of business, industrial, agriculture and scientific research in a country. Each of these has a strong influence on social development. One of the problems in developing countries is the inability to use the information communication technology effectively to solve the emerging issues that are mathematically oriented so as to compete equally with developed nations. This is compounded by the fact that these developing nations have got few experts to handle the technology at hand, (Lerman, 1997).

Mathematics teachers at secondary school level in Kenya are, by requirement mathematics graduates with bachelors degree in education (B.Ed). Shortage of qualified mathematics teachers is a worldwide phenomenon and Kenya is no exception, (Anderson, 1998). Secondary schools in disadvantaged areas are particularly deficient in mathematics teachers. The situation is worse in special schools for learners with disabilities. The result is that less qualified teachers and sometimes unqualified teachers are entrusted with the work of mathematics teaching, (Philips, 1984), which is detouring the whole system of education. This is also due to few teachers and limited communication technology that would make the learning of mathematical concepts easy to understand if they are well introduced, (Government of Kenya, 1998).

The students' achievement is therefore influenced to some degree by such variables as teachers' training and effectiveness, students' effort and ability, instructional methods, physical health and the nature of instructional contact (Coolican, 1989). As Malone, (1981) observes, gender influences the learning of mathematics, and that the differences begin to appear in upper primary schools and increases in secondary schools. In the year 2006, the mean grade in mathematics for girls and boys with physical disabilities in KCSE was 0.821 and 1.122 respectively, (KNEC 2007). The low achievement in girls has been attributed to modes of teacher-student interaction and negative attitudes of girls towards mathematics. Kiboss (2000) observes that cooperative learning like the use of CBL produces significantly higher achievement in sciences among secondary school students than those taught in the traditional teaching methodologies. However, this literature did not capture the effect of CBL on mathematics performance with specific reference to learners with PD in Kenya which the study determined with the aim of adding new knowledge for the benefit of the named learners. Introducing CBL therefore intended to provide the students with expanded perspective on content to ensure effective en route mastery during embedded questioning and it was an incentive to cooperate as well as to achieve in the classroom.

Kiboss (2000), in the Journal of Information technology for Teacher Education 9(3).199-213 wrote an article on Teacher/pupil perspectives on computer-augmented physics lessons on measurement in Kenyan secondary schools. He used selected secondary schools for the non disable learners in the then Rift Valley that sampled 1200 population. Instruments used were both questionnaires and interview schedules and used only multiple regression analysis in analyzing quantitative data. Kiboss (2000) observed that cooperative learning like the use of CBL produces significantly higher achievement in sciences among secondary school students than those taught in the traditional teaching methodologies.

Geary, (2001) who authored *Mathematical disabilities: What we know and don't know* as retrieved November10,2006, concurs with Kiboss that using computer based learning produces significantly high performance than using traditional mode of teaching. The study location and population of Geary was different from that of Kiboss because he did his research in Texas, USA, using entirely different, none disable sample population of 86.However, these authors did not capture the effect of CBL among learners with disabilities with specific reference to Mathematics subject. In their analysis however, they did not used Pearson's r which would have clearly check on the direction of relationship, whether positive or negative, established the strength of the said relationship and guide the researcher in either accepting or rejecting the null hypothesis.

2.4.1 The relationship between teachers and students exposed to CBL and those without that exposure in their performance in mathematics

The CBL in mathematics provide the teachers with the effectiveness to provide and organize concrete problem solving in offering data gathering experiences for students that increases skills, understanding, and positive attitudes, (Woener *et al.,* 1991; Smith &Pohland 1991). The tutorials provide interaction with best and animated graphic materials that illustrate the concepts or processes being studied and give useful corrective feedback when students choose wrong answers, (QUEST Authoring System, 1991).

The manual explains that the computer programs supplement concrete experiences or stimulate them. In simulation, students are given opportunity to develop science and process skills. In biology, computer software have been used to provide a realistic game that encourages students to determine various aspects of animal life like predator-prey relationship of fish and other organisms in an aquatic environment or in body transplant, which offers a set of games that stimulate the dissection of the human body. The chemistry laboratory stimulates actual laboratory chemical realities that are too dangerous or costly to do in real life. In physics CBL allow students to design, construct, and refine various aspects of the subjects like motion or measurements and calculations (Kiboss, 2000; Stake, 1991).

And in Geography various programmes like the EARTH, and THE MOON Simulator (Woerner *et al.*, 1991; Stallings, Hutchinson & Sawyer, 1996) shows the relative path of the earth and the moon as they orbit the sun, the phases of the moon as seen from the earth and from space. Ellis (1989) and Rees (2002) note that inspiration software allows students to create webs of ideas that are converted into outline form to be used for essay writing. Mathematics has also come out with programs used by computer to each concept and skills of the subjects like the Copycat software. The first schools to own computers were a few rich private and public secondary schools. Some of these were beneficiaries of the Computer in Education of the Aga Khan (CEPAK) (Kiboss, 2002).

In 1980, Starehe Boys' Centre introduced a computer awareness course for learners. Other schools have since joined the club of computer owners. Review of computer ownership in year 2002 showed that about one thousand secondary schools had at least a few computers, which could be utilized for instruction purposes assuming there were enough data and manpower to operate them. It is the Kenya government's desire to disseminate ICT to all schools by the year 2020, (Government of Kenya Report, 2000).

The aim of introducing computer knowledge to learners in secondary schools is to equip them with skills on the use of computers. Little is currently mentioned on the use of computers for instruction purposes in Kenya as it is in South Africa, U.S.A and Europe (Papert, 1993). There is need to emphasize this idea in the minds of educational officials, teachers and students to make use of the ICT since a computer is a powerful tool that will stay with us for many generations to come, (Kiboss, 2000).

Large scale implementation of CBL programs in secondary schools is hindered by the high cost of computers and the constant change in the type of computers and software which causes computer incompatibility (Ogola, 1999). Despite the cost and the logistic difficulties involved in computer acquisition and installation, computational technology and computational ideas can provide teachers and students with new possibilities for learning, thinking and growing emotionally as well as cognitively, (Papert, 1993). Adaptation of the same computers to suit all the learners of diverse disabilities could provide an opportunity for those with degenerative disorders to learn with ease and perform in mathematics like their non-disable peers.

2.4.2 Traditional Instruction

Traditional instruction is teacher-centered and characterized by direct instruction. Direct instruction usually includes the presentation of material, thinking aloud by the teacher, guided practice, correction and feedback, and modeling by the teacher, (Kinney and Robertson, 2003). The teacher plays the role of the expert imparting knowledge. The teacher decides what, when, and how students should learn (Brown, 2003; Kinney and Robertson). All students study the same topic at the same time. The facilitator and delegator teaching styles, which are student-centered, were used less in mathematics and computer science classes than in any other discipline.

The tendency is for teachers to use the same instructional methods with which they were taught and with which they feel comfortable. This often means that developmental mathematics students have been and still are receiving instruction by the traditional lecture (Armington, 2003;

Maxwell, 1979; Miles, 2000; Roueche and Kirk, 1974). In colleges and universities, the predominant mode of instruction has been the presentation of material through lecture and demonstration using whiteboard, chalkboard, overhead, PowerPoint, or graphing calculator, (Armington, 2003). The teacher talks and students listen and write. The teacher demonstrates step by step procedures which are reinforced with drill and practice. Interaction is limited to students responding to the teacher's questions. Some educators have a very negative view of the traditional lecture.

According to Brown (2003), the teacher is responsible for thinking and the students memorize and recite. More often, teachers are focused on content, schedules, and standards, not needs of the students. Felder and Brent (1996) describe the traditional lecture as stenography with the teacher reciting the course notes, the students transcribing the notes, and "the information not passing through anyone's brain" (p.3). Professors that teach by lecturing operate under the assumption that if they do not lecture they will lose control of the class. Students are viewed as empty pails waiting to be filled and the teacher as the "sage on the stage" (Mahmood, 2006, p.25).

According to Brothen and Wambach (2000), faculty, students, and administrators think that teaching means "speaking aloud from the front of the room" (p.64). Based on their research on a developmental psychology course, they concluded that lectures are an inefficient means of delivering instruction. Traditional instruction that is purely lecture has not been effective for developmental mathematics students. As early as 1974, Roueche and Kirk concluded that traditional approaches have not been successful with developmental students. They have already received instruction at least once on the same material.

Most likely it was presented by the traditional lecture mode of instruction (Trenholm, 2006). If the traditional lecture had been successful, then they would not be in developmental classes. Teaching developmental mathematics in the traditional large lecture classes has produced low pass rates and high dropout rates (Wright, Wright, and Lamb, 2002). At Southwest Texas State University, over 50% of students receiving traditional instruction in Intermediate Algebra received a D or F in the subsequent math course, but 60% of the students receiving non-traditional instruction received a C or better in their next mathematics course (Armington, 2003).

Educators have implemented various strategies to make classroom instruction more active and less passive. Some enhancements to the traditional lecture that are associated with higher pass rates are lectures supplemented with collaborative work (Kinney, 2001; Perez, 1998), peer tutoring (Kinney; Perez; Roueche and Kirk, 1974), computer labs (Kinney; Miles, 2000), group learning activities (Felder and Brent, 1996; Wright, Wright, and Lamb, 2002), class discussions, peer study groups and Supplemental Instruction (Perez). Some instructors have found increased learning by limiting presentation of the material to the first 10 or 15 minutes followed by individual instruction and student work (Armington, 2003). Cooperative learning techniques encourage students to take responsibility for their own learning and solve problems with their peers, (Armington; Felder and Brent). Some instructors use graphing calculators and spread sheets to enhance the teaching of real-life problems, (MacDonald *et al.*, 2002).

Most community colleges in Virginia limit class size to 20 or 25 students (Waycaster, 2001). Some universities have established mentoring programs and learning communities (Perez).

Providing support services outside the classroom, such as tutoring, academic advising, study skills workshops, freshman orientation, and Supplemental Instruction are important to the success of developmental students (Gerlaugh, Thompson, Boylan, and Davis, 2007). Strategies that encourage students to become responsible for their own learning, build their confidence, teach study skills, encourage persistence, and decrease math anxiety have been shown to contribute to higher success rates (Perez; Hall and Pontoon, 2005; Higbee and Thomas, 1999; Roueche and Kirk).

Student surveys, focus groups, and questionnaires have shown that students choose lecture style classes because they prefer to learn by observing an instructor present the material, asking questions in class, listening to questions from other students and the instructor's response, and having the opportunity for more human interaction (Kinney, 2001). In addition, they were interested in learning math with a computer. But this is tailored towards the non-disable children and little is discussed on the effect of these strategies especially CBL on mathematics performance and motivation of learners with PD.

2.4.3 Traditional Instruction Supplemented with Computer Based Learning

Computer-Based Learning, also referred to as computer-based use and computer-enriched instruction, can support traditional classroom instruction. The software typically includes problems generated algorithmically, videos of each lesson, online tutoring, and a website with additional resources (Kinney and Robertson, 2003). It is designed to supplement but not replace the instructor. In this instructional model, students receive instruction in traditional classrooms, but the computer changes how they study outside the classroom. The computer component is available 24 hours a day from any computer with internet capability, so each student can choose when, where and how long he works outside the classroom. Instructors may create electronic homework, quizzes, and exams that are graded and recorded by the software.

Drill and practice software leads the student through exercises designed to build accuracy and speed, assuming the student has received prior instruction (Kulik and Kulik, 1991; Olusi, 2008). Interactive tutorials include guided practice problems, which encourage students to be actively engaged with the learning process (Mahmood, 2006; Merisotis and Phipps, 2000). Software can provide a student with an individualized study plan based on his scores on homework and quizzes (Cotton, 2001; Hannafin and Foshay, 2008). There is an element of competition as the student competes against his own previous score. Software can be programmed for mastery learning so a student does not proceed to the next lesson before mastering the current one.

Computer-assisted instruction permits the student to work at his own pace and to receive immediate non-judgmental feedback on assignments (Cotton; Hannafin & Foshay; Merisotis & Phipps). Frequent testing and feedback has been identified by the National Association of Developmental Education as one of the best practices of developmental education (Boylan, 2002). Instructional management features store, organize, and process scores, response times, and other data that inform instructors and students how students are progressing in the course (Ford and Klicka, 1998).

Computers as instructors have several advantages over human instructors. The computer has infinite patience but a human does not (Kulik and Kulik, 1991; Mahmood, 2006). The student can revisit the same topic numerous times until he has mastered the concept and developed confidence (Brothen and Wambach, 2000). Computers do not get tired, frustrated, angry, or bored (Kulik and Kulik 1991). They keep accurate records and are always available. If they are programmed to do so, computers always remember to praise the student's work (Cotton 2000; Mahmood 2006). A student can take risks to try a solution, get instant feedback, and try again without being embarrassed when he makes a mistake.

Unlike a human instructor, computers are impartial to gender, race, and ethnicity. In addition, students report they like working with computers because they teach in small increments, individualize instruction, build proficiency in computer use, reduce the drudgery of doing certain activities by hand, and allow teachers to be available for more meaningful interactions (Cotton, 2000). Computer based use encourages students to take responsibility for their learning, acquire effective study habits, and persist until he has mastered the content (Brothen & Wambach, 2000). He can control when he works and how much time he spends on each lesson (Reagan, 2004).

By supplementing traditional classroom instruction with computer based use, students receive the benefits of both instructional modes. According to Maxwell, developmental mathematics students need to see the instructor work problems (1979). Instructors are able to observe individual students work, identify their misconceptions, and attempt to change their attitudes and study habits. By providing short lectures, the instructor is preparing developmental students for the lecture approach that is used in other mathematics courses.

2.4.4 Computer Based Learning

According to numerous researchers, colleges should offer developmental students choices of instructional approaches. Since developmental students are very diverse in mathematical background and have a variety of learning styles, no one instructional style will meet the needs of all students (Boylan, 2002; Felder and Brent, 1996; Higbee and Thomas, 1999; Kinney and Robertson, 2003; Miles, 2000; Perez, 1998; Roueche and Kirk, 1974; Waycaster, 2001). Computers and the internet make possible new methods of delivering instruction to developmental mathematics students so that they will have choices about when, where, and how they learn mathematics.

Standards developed by the American Mathematical Association of Two-Year Colleges call for a greater use of technology in the classroom (AMATYC, 1995). Emphasis should be on high-quality technology that enhances student learning but does not become the main focus of instruction. AMATYC emphasizes that just the presence of computers or other technology does not improve learning. In 2000, the National Council of Teachers of Mathematics published *Principles and Standards* for the purpose of improving student learning. The Technology Principle states that "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (p.3). Computers, when used effectively, can support fundamental characteristics of learning: active engagement, participation in groups, frequent interaction and feedback, and connections to real-world contexts (Roschelle, Pea, Hoadley, Gordin, & Means, 2000).

Technological advances have made computers more powerful and less expensive, which have resulted in more students having access to computers at home and at school (Rapaport & Savard, 1980). The internet has the potential to provide a learning environment that is stimulating and engaging. Educators are able to design a wide array of courses that appeal to the inclination of current college students to use technology and potentially increase learning and retention

(Trenholm, 2006). According to a 2002 Pew Internet and American Life Project, 20% of today's college students began using the computer between five and eight years of age, 85% have their own computer, and 79% say that the internet has had a positive impact on their college academic experience. College students frequently use the internet to check email, download music files, instant message, browse for fun, and communicate with family, friends, and professors.

Computer based use is an alternative to traditional instruction used both for on-campus and distance learning courses, providing individualized, self-paced instruction. Computer-assisted instruction, according to some researchers, has great potential for developmental education because it allows a student to work at his or her own pace, provides immediate feedback, guided practice problems, and 24-hour access (Kinney, 2001; MacDonald *et al.*,, 2002; Merisotis and Phipps, 2000; Miles 2000). In 1976, only ten percent of the institutions surveyed used computer-assisted instruction to teach mathematics (Maxwell, 1979). According to the National Center for Educational Statistics (2003b), in the fall of 2000, 31% of the 3230 colleges surveyed reported that computers were frequently used by students as a hands-on instructional tool for on-campus remedial mathematics, and 13% offered remedial courses through distance education, an increase from 3% in 1995.

Computer-assisted instruction is supported by the early work of Roueche and Kirk (1974). One of their eleven recommendations for effectively serving remedial students is to accommodate individual differences and permit students to learn at their own pace. According to Roueche and Kirk, "*Individualized instruction is critical to the effectiveness of developmental programs*" (p.88). They did not advocate any particular methodology but asserted that lectures are not appropriate for remedial students. Teachers should not stand in front of the class and talk at the students. Developmental students typically do not have the reading and listening skills to succeed in traditional instruction. They learn best by being active learners, by seeing and doing instead of listening.

Computer-assisted instruction requires seeing and doing as students use the interactive tutorials and other multi-media. Beginning in the early 1960s computer-assisted instruction was used almost exclusively to drill, tutor, and test students (Kulik & Kulik, 1991). With the rapidly changing capabilities of computer software and hardware in recent years, computer-based instruction now has a greater variety of possible uses. Textbook publishers have developed much of the software currently being used in developmental mathematics (Kinney & Robertson, 2003). It typically is one of two models: (1) software designed to support a traditional course with the instructor providing the content and the software providing videos and algorithmically-generated problems and (2) software designed to provide a thorough presentation of concepts with interactive multimedia and the instructor as facilitator.

In the selection of software it is critical to first determine whether the learning is teacher-entered or student-centered. Software can be used in a variety of instructional formats: a supplement to direct instruction, a component of a hybrid course that combines teacher-centered and student-centered instruction, independent learning in an open computer lab with tutors available, computer-mediated learning that is student-centered and meets in a classroom with the same students and same instructor, and distance learning with no face-to-face contact between student and instructor. The current study focuses on computer-assisted instruction as a supplement to traditional instruction and computer-assisted instruction in distance learning courses.

2.4.4.1 Software Programs for Teaching Mathematics

Some of the existing soft wares for teaching mathematics as used in developed countries for learners with physical disabilities include; *MathPad,* which enables students to do arithmetic directly on the computer. The program is ideal for students who need help organizing or navigating through math problems or who have difficulty doing math with pencil or paper. Features include *Auto Navigation* which guides students as they do their calculations; auditory feedback where students can save their work in individual portfolios. Teachers can enter problems they create for their students, or use the 300 sample problems that come with the program and Adjustable font sizes and colors, which enhance readability. Student work can be printed from here.

There is also *Number Navigator***,** which a "maths processor" program is designed for people who want to do addition, subtraction, multiplication and division on a computer screen. Includes sample files with maths problems, or you can enter your own sums to make computer based maths worksheets. The program does not provide answers to the problems, but rather allows the student to lay out sums as they would be done on paper. On top of this, there is also *Access Math 4.0* which is a drawing package for maths activities. It has features that will enable user to use the computer to draw measure and colour geometrical shapes. It include a range of tools such as a ruler, compass, protractor, and options to draw circles, lines, triangles and many other shapes. (Beehler & Snowman, 1982; Black, 1998).

Clikka Mouse Free Description program on the other hand allows a learner with physical disabilities to control the functions, both in Windows and in any other program which require the use of a mouse device: left or right click, double click, scrolling, etc. It should be used together with other mouse emulator programs such as head or eyes pointers or any other processing system designed for people with disabilities. Clikka Mouse Free (with its bars hidden on the left side of the screen allowing the whole view of your desktop) "silently" provides a learner possibility to click whenever he wants to, just leaving the cursor rested over a given button on the screen, allowing the learner to rest too and putting all the functions in stand-by. The program, once started, will display a bar, hidden on the left side of the screen; the bar will show some buttons which can be enabled or disabled by simply resting with the cursor over the selected one for a certain amount of time, (Black, 1998).

There is also *IBM via Voice (Voice Recognition),* a software for people with limited movements. It allows voice activation control of most software. Designed for executives, professionals and writers who place a premium on fast, effective computer communications, Pro USB Edition comes with a be stereo USB headset microphone with a digital signal processor for higher speech recognition accuracy -- the most advanced microphone ever included in a ViaVoice software product. Designed for speech recognition, this full-range stereo microphone is great for listening to MP3s, CDs and DVDs as well. It can apply to teaching maths to children with physical disabled as well.

2.4.4.2 GeoGebra as a software Tool for Teaching and Learning Mathematics

GeoGebra is dynamic mathematics software that joins geometry, algebra and calculus. It was developed for learning and teaching mathematics in schools by Hohenwarter, (2002); an international team of programmers. GeoGebra provides three different views of mathematical objects: a Graphics View, a Numeric Algebra View and a Spreadsheet View. They allow you to display mathematical objects in three different representations: *graphically* (e. g., points and function graphs), *algebraically* (e. g., coordinates of points, equations), and in *spreadsheet cells*. Thereby, all representations of the same object are linked dynamically and adapt automatically to changes made to any of the representations, no matter how they were initially created, (Hohenwarter, 2002).

Using the *construction tools* available in the *Toolbar* one can do geometric constructions in the *Graphics View (GV)* with the mouse. Select any construction tool from the *Toolbar* and read the *Toolbar Help* (next to the *Toolbar*) in order to find out how to use the selected tool. Any object you create in the *Graphics View* also has an algebraic representation in the *Algebra View*. After activating the tool, you are able to *move objects in the Graphics View* by dragging them with the mouse. At the same time, their algebraic representations are dynamically updated in the *Algebra View*. Every icon in the *Toolbar* represents a toolbox that contains a selection of similar construction tools. In order to open a toolbox, you need to click on the small arrow in the lower right corner of the *Toolbar* icon.

Construction tools are organized by the nature of resulting objects or the functionality of the tools. You will find tools that create different types of points in the *Point Toolbox (PT)* and tools that allow you to apply geometric transformations in the *Transformation Toolbox (TT)*, (Hohenwarter, 2002).Using the *Input Bar* you can directly enter algebraic expressions in GeoGebra (GG). After hitting the Enter-key, your algebraic input appears in the *Algebra View* while its graphical representation is automatically displayed in the *Graphics View*. Example, the input f(x) = x^2 gives you the function f *in* the *Algebra View* and its function graph in the *Graphics View*.

In the *Algebra View (AV)*, mathematical objects are organized as *free* and *dependent objects*. If you create a new object without using any other existing objects, it is classified as a *free object (FO)*. If your newly created object was created by using other existing objects, it is classified as a *dependent object*. If you want to hide the algebraic representation of an object in the *Algebra View*, you may specify the object as an *auxiliary object*: Right click on the corresponding object in the *Algebra View* and select *Properties* from the appearing context menu. By default, *auxiliary objects* are not shown in the *Algebra View (AO)*, but you can change this setting by selecting the item *Auxiliary Objects* from the *View* menu.

Note that you are able to modify objects in the *Algebra View* as well by ensuring that you activate the *Move* tool before you double click on a free object in the Algebra View. In the appearing text box you can directly edit the algebraic representation of the object. After hitting the *Enter*-key, the graphical representation of the object will automatically adapt to your changes. If you double click on a *dependent object (DO)* in the Algebra View, a dialog window appears allowing you to *redefine*the object, (Beehler& Snowman, 1982; Black, 1998).

GeoGebra also offers a wide range of *commands* that can be entered into the *Input Bar (IB)*. You can open the list of commands in the right corner of the *Input Bar* by clicking on the button *Command*. After selecting a command from this list (or typing its name directly into the *Input Bar*) you can press the *F1*-key to get information about the syntax and arguments required to apply the corresponding command, (Hohenwarter, M. 2002).In GeoGebra's *Spreadsheet View* every cell has a specific name that allows you to directly address each cell. *For example,* the cell in column *A* and row 1 is named *A1*.These cell names can be used in expressions and commands in order to address the content of the corresponding cell.

In the *spreadsheet cells* you can enter not only numbers, but all types of mathematical objects that are supported by GeoGebra (e. g. coordinates of points, unctions, and commands). If possible, GeoGebra immediately displays the graphical representation of the object you entered in a *spreadsheet cell* in the *Graphics View* as well. Thereby, the name of the object matches the name of the *spreadsheet cell* used to initially create it (e. g., *A5*, *C1*). By default, spreadsheet objects are classified as *auxiliary objects* in the *Algebra View*. You can show or hide these *auxiliary objects* by selecting *Auxiliary Objects* from the *View* menu.

2.5 Challenges faced by Learners with PD while using computers

Shayer, (1998) observes that a child's cognitive development is achieved by internalizing a successful performance seen in another person in their social environment and by working collaboratively with their peers in the construction of more powerful strategies.

The learner through interacting with the world constructs, tests, and refines cognitive representation to make sense of the world, (Boyle, 1997). The role of the teacher is to perform the operations the learners cannot yet handle on his or her own and gradually remove the support. This is 'fading' up where the learner is made to become increasingly independent in their application of skills and knowledge acquired in the class.

In this case, the teacher supports the learner who acts as an apprentice, (Shayer, 1998). The computer in this case plays the role of an enabling component for representation, communication and evaluation for better learning. Learning therefore, produces change in capacity for performance that could be observed as a result of the situation, (Good & Brophy, 1996). The learner's experiences in class or out of class may impede or enhance learning. Heywood, (1998) and Billet, (1996) noted that experience is a powerful ally of perception. Any misconception in a learner can therefore hinder the process of learning.

Hutchingson, *et al.,* (1992) observes that learning can either be situated or distributed. Learning as situated describes the way people learn. The cognitive abilities they use to learn depend on the nature of the learning situation some of which are active, passive, creative, reactive, directed, and some exploratory. The nature, of the learning and of tools and situations that support it is task dependent. Learning is distributed between the internal goals, representations and actions of the learner and the external form of the learning materials and their delivery. Learning goals and actions are likely to be shaped by the moment-to-moment display of information in front of them.

The responsibility of any teacher in either a CBL class or TI class is to provide effective instructional media and an enabling classroom environment to pupils (Lambrecht, 1989). Such teachers should have such personal attributes as: Knowledgeable of learning processes, Competency in the use of variety of instructional strategies and Effectiveness in interpersonal communication. A teacher should have the ability to bring out the goodness of the subject to the pupil as means of motivating them, (Boone & Kurtz, 1987).

Students with learning disabilities and those with PD in particular should receive some time on a regular basis with some explicit systematic instruction. There is no reason to believe that this type of instruction should comprise all the mathematics instruction these students receive. However, it does seem essential for building proficiency in both computation and the translation of word problems into appropriate mathematical equations and solutions. Some of this time should be dedicated to ensuring that students possess the foundational skills and conceptual knowledge necessary for understanding the mathematics they are learning at their grade level.

However, with the advent of the new technology, challenges have been witnessed especially in respect to the learners with disabilities, (Kiboss,2000).A physical handicap condition among the learners may affect how a student performs in the classroom if there are no suitable adaptations put in place to cater for the needs of this category of learners. Because of laws such as Individuals with Disabilities Education Act (IDEA) and advances in technology software, students with physical disabilities can succeed in the classroom. Technology can be a powerful "equalizer" for people with disabilities, allowing them to "get around" a limitation in any number of areas, (Boucher, 1998).

Students with physical disabilities may have difficulty performing basic functions such as, gripping objects with their hands, moving arms or legs in a full or even limited range of motion. Technology has played an important role in attempting to bridge the gap necessitated by this handicapping condition. However the process of using the CBL has led to some challenges in handling mathematics in the classroom such as using keyboards, touch screens, computer mice, and scroll wheels which are all used with the technology, Hohenwarter, (2002).

Children with physical disabilities may have multiple disabilities which can include speech difficulties, physical mobility problems, learning difficulties, mental retardation, visual impairments, hearing impairments, brain injury and possibly others. Along with multiple disabilities, they can also exhibit sensory losses and behavior and/or social problems. These students may exhibit weakness in auditory processing and have speech limitations. Physical mobility will often be an area of need, Hohenwarter, (2002). These students may have difficulty attaining and remembering skills and/or transferring these skills from one situation to another.

Support is usually needed beyond the confines of the classroom. There are often medical implications with some of the more severe multiple disabilities which could include students with cerebral palsy and severe autism and brain injuries. Manipulation and in-depth understanding of computer operations among these children for success in mathematics can be a challenge, (Beehler& Snowman, 1982). Students ease in manipulation of computers is characterized by behaviors which include students taking responsibility for their learning while using CBL.

Students' positive attitude towards learning as reflected in their willingness to learn independently at extra hours with the help of computer and students working in pairs and groups making student collaboration strengthened and allowing more ideas to be shared hence enriching their knowledge, Hohenwarter, (2002). Literature is mostly reviewed on the challenges that learners with disabilities face while using computers to do general work but there is no study that have attempted to discuss the challenges that specifically the learners with PH face while using CBL to do mathematics and offer possible solutions on the same in order for them to maximally benefit from their learning.

2.6 Summary

It can be observed that the USA and Western Europe have built a strong base for the use of computers in education. This largely has been attributed to developed infrastructure and large investment in computer technology. Despite the notable progress in readiness in Africa, there still exists a large digital divide between the developing and the developed countries. In Kenya, the government's prioritization of using computers in teaching and learning mathematics is very low and there is need for a paradigm shift in matters pertaining leadership in computer technology so that the country can leap the benefits of computer technology in education. The study aimed at investigating the factors affecting the use of computers in teaching and learning mathematics.

The Kenyan government recognizes the role of computer technology in helping to attain the education goals of vision 2030, which are to provide globally competitive education, training and research for development. Learners with special needs and those with PD specifically are part of Kenyan student community and any policy/programme rolled out by the Government of Kenya affects them. Therefore, use of CBL as an aid should be plan and use by all learners irrespective of the disability.

Among the implementation strategies specified by the government is to establish a computer supply program that will equip students with modern ICT skills (Karanja, (2011). There however exists a gap in knowledge today as pertains to the factors affecting the use of computers in teaching and learning of mathematics among learners with PD in secondary schools in Kenya. This study therefore aimed to fill this gap by describing the factors affecting use of computers in the teaching and learning of mathematics among learners with PD so as to help in achieving the education aspirations of vision 2030 which are to reduce illiteracy by increasing access to education, improve transition rate from primary to secondary and raise the quality of education and relevance of education for all.

The study has also shown the importance of practice and drill to encourage learning through self-reinforcement a component of computer use. It is therefore worrying for a country in its nascent state of development and targeting a leap in industrial and technological advancement that such an important tool is not a major component in the training of its future workforce. The study intends to point out the main impediments to the non-integration of computers in the teaching and learning process among the learners with PD.

CHAPTER THREE

METHODOLOGY

3.1 Research Design

A pre test counterbalanced design was used. The design equates the treatment and control groups and can give the most reliable results at the end of the experiment Leedy and Ormrod 2010; Coolican, (1999). In this design, the treatments are given to all the groups in a different order, and the number of groups should be equal to the number of treatments.

The researcher carried out the study using three Secondary schools; The Joyland Secondary School for the physically disabled, (School 1), The Joytown Secondary School for the physically disabled, (School 2) and Mombasa Secondary school for the physically disabled, (School 3). Schools 1 and 2 had two streams each, herein named as Groups 1 &2; in there form three classes while school 3 was a single stream and had no computers that could be used for CBL. All the 32 learners of Form three in Mombasa Secondary school for the physically disabled, (school 3) were therefore used as control to experiment. The pre-test was administered in order to get the baseline information from the groups before the experiment. The experimental and the control groups were interchange after two weeks in schools 1 and 2 as shown in Table 3 below.

Table 3: A pre Test Counter Balanced Design

Design Week	School 1		School 2		School 3
	G 1	G 2	G 1	G 2	All class
1	PT	PT	PT	PT	PT
2 - 5	TT (CBL)	N T (R I)	N T (R I)	TT (CBL)	NT (RI)
6	T M =	T M =	T M =	T M =	T M=
7 - 10	N T (R I)	TT (CBL)	TT (CBL)	N T (R I)	NT (RI)
11	T M =	T M =	T M =	T M=	T M=

Key;
PT- Pretest **T**- Test **M**- Mean **G1**- Group 1 **G2**- Group 2 **S1**-School 1 **S2**-School 2, **RI**- Regular Instruction **NT**- No Treatment **TT**- Treatment
S3- School 3

3.2 Study Area

The study was carried out in Kisumu, Thika and Mombasa Counties using Joyland (JL), Joytown (JT) and Mombasa Secondary School (MSS) for the physically disabled. JL is located East of Kisumu city, approximately 5 Km away; JT is located East of Thika town approximately 6 Km away.

3.3 Study Population

The population of the study comprised a total of 156 Form three students from the three secondary schools for students with physical disabilities in Kenya, namely Joytown (JT), Joyland (JL) and Mombasa secondary schools (MSS) for the physically disabled. It also included a total of 7 teachers for mathematics from the named schools as shown in table 4 below.

3.4 Sample Size and Sampling Techniques

There were a total of 7 mathematics teachers from the named schools out of which 1 teacher from JT and another 1 from JL were used for piloting and the remaining 5 teachers purposively sampled for the study. Saturated sampling was used to get 128 Form three students that participated in the study. The remaining 28 students had been used in piloting. From Joyland secondary school, only 52 students participated in the study. A total of 44 students from Joytown Secondary School in Thika were used. All the 32 Form three students from Mombasa Secondary School for the physically disabled and their mathematics teacher were used as control group in the study. This was due to the fact that the school was a single stream and had no computers that could be used for CBL. Form 3 class was used because the software used, CAST was developed and already in use in Form three classes. The information is shown in Table 4 below.

Table 4: Target and Sample Population of the Study

Category	School 2		School 2		School 3		Total	
	Target	**Sample**	**Target**	**Sample**	**Target**	**Sample**	**Target**	**Sample**
FormThree students	60	44	64	52	32	32	**156**	**128**
Maths Teachers	3	2	3	2	1	1	**7**	**5**
Total	**63**	**46**	**67**	**54**	**33**	**33**	**163**	**133**

Key; School 1 - Joyland Secondary School

School 2 - Joytown Secondary School

School 3 - Mombasa Secondary School for the physically disabled

3.5 Research Instruments

Six instruments were developed and used in the data collection for this study namely; Computer Assisted Statistical Text (CAST),Pre-Test, Test 1,Test 2, the student interview guide (SIG), and teacher's interview guide (TIG). The researcher personally visited the schools identified to experiment and collect relevant information.

3.5.1 Computer Assisted Statistical Text (CAST)

Computer Assisted Statistical Text (CAST) was used to collect data during the instruction of the lesson. It helped in lesson planning and actual execution of the lesson. It directed the learners accordingly and provided for self evaluation at the end of the lesson for self improvement as shown in Appendix A.

3.5.2 Pre-Test

This was administered to all sampled students at the beginning of the study to an a diagnostic test to establish the level of the learners performance before treatment. (Appendix B.)

3.5.3 Test 1

This was administered to all the sampled students in schools 1, 2 and 3 after four weeks of subjecting half of the group in schools 1 and 2 herein named as G1 and G2 to CBL use as shown in Fig 1 in pp 77.The other half groups,i.e G2 and G1 in the named schools plus all the 32 students in school 3 were used as control. (Appendix C.)

3.5.4 Test 2

This was administered to all the sampled students in schools 1, 2 and 3 after another four weeks of swapping the application of CBL use to half of the initially traditionally instructed group in schools 1 and 2 herein named as G2 and G1 as shown in Fig 1 in pp 77.The other half groups,i.e G1 and G2 in the named schools plus all the 32 students in school 3 were used as control. (Appendix D.)

3.5.5 Student Interview Guide (SIG)

Student interview Guide helped the researcher on the informal talks with the subjects. The oral interview helped the researcher identify the students' feelings about their mathematics course through the CBL or their teacher mode. The questionnaire was an objective type and had seven items that were checked by the interviewer during the interview. It helped in describing the students' reactions regarding mathematics (Appendix E).

3.5.6 Focus Group Discussions for Teachers

Focus group discussions with the teachers were conducted in order to obtain some background information about the class, whether teachers of mathematics were trained and ready to teach learners with PD using computers, challenges faced, strategies of improving use of CBL and incorporating the teachers in acquisition of software by school administration. The purpose of the focus group discussion was to find out any additional information on the use of CBL in mathematics lesson. The information could help the researcher to know the level of computer literacy among teachers and their ability to use the same knowledge in instructing the learners in class. (Appendix F).

3.6 Piloting

Piloting of the instruments was done before the commencement of the study using Form three class students in the three schools, which were 28 students in number and 2 teachers. The students and teachers used were those who were not included in the main research.

3.6.1 Validity of Research Instruments

Validity refers to correctness or soundness of conclusion reached in a study. (Kothari, 2008:73; Pelto 1973:33; cited in Scrimshaw, 1990:83).It is the extent to which an instrument purports or measures what it is designed to measure. Content validity was determined by the researcher by discussing the research instrument with his supervisors and colleagues too. The guidance given was used to improve the validity of the instrument after making the necessary changes. The research experts from the school of education and supervisors requested to review the items based on the objectives and the purpose of the study. The validity also was verified through a pilot study. Besides, student colleagues in the same study area were to check the items for face and content validity.

3.6.2 Reliability of the Research Instruments

Reliability is the extent to which a research instruments yields measures that are consistent, (Mugenda & Mugenda, 2009). It refers to the degree of consistency or repetition of the results of a study. This infers the production of the same results when used by someone else. It has two aspects of stability and equivalence. The degree of stability was determined by comparing the results of repeated measurements while the equivalence considered how much the error had been introduced to investigations or samples.

The test- retest method was used to test reliability. The questionnaire was administered during the pilot study. Cronbach's Coefficient Alpha was used to establish the reliability of the research instrument. A reliability coefficient of 0.7 and above was assumed to reflect the internal reliability of the instruments (Fraenkel & Wallen, 2000). Since the value obtained was 0.865 for student questionnaire, it showed that this value was above 0.7 and the questionnaire deemed reliable. The typographical errors and omissions detected were corrected in the instrument confirming that it was sufficient to be used in the main study.

3.7 Data Collection Procedure

Letters were written to seek permission to carry out research in the stated areas. The approval to conduct research in the named areas was sought through the national council for science and technology innovation (NACOSTI) and the head teachers of Joytown Secondary School in Thika county, Joyland secondary school for the physically disabled in Kisumu County and Mombasa Secondary School for the physically disabled in Mombasa county. The researcher personally visited the areas of study to experiment and collect relevant information. The researcher discussed with the head teachers of the named schools the purpose of the study and the general overview of the tools to be used. The same discussion was extended to heads of mathematics department, computer laboratory technologists and research assistant in respective schools. To ensure that the data collected in pre-Test, Test 1 and Test 2 was standard, the researcher facilitated a one day meeting in Nairobi for the sampled teachers of mathematics from the three schools where the tests and there respective marking schemes were set based on the Form 3 syllabus.

The researcher discussed with the respective respondents the issues at hand and distributed the questionnaires after agreeing with them on how to be completed. The students completed in their respective classrooms while teachers did theirs in the departments. Data from CAST was personally collected by the researcher with the help of research assistant in the computer laboratories of the named schools. This was done after the students had been briefed on what was expected of them and the same process was repeated for the treated group after the exposure (post-test).The treated groups were then asked by the researcher to respond to questions at the end of CAST on their contributions about the use of CBL.

3.8 Data Analysis

Because of the nature of information collected, quantitative and qualitative data analysis was carried out in the study. Quantitative data analysis involved making sense of things or events intuitively, conceptual grouping and figurative grouping data, exploring "what is there", clustering and distinguishing observations with respect to variables and assembling a coherent understanding of events. Pearson's r and multiple regression analysis were used to determine the relationship and to predict students' performance in mathematics.

Inferential statistics on the other hand was useful in making objective comparisons of results about the subjects, (Coolican, 1999). Percentages, means, standard deviations were obtained while analysis of variance (ANOVA) was performed on the data. Qualitative aspects of the statistics was analysed by transcribing and categorising the data into themes and subthemes and reporting some of them verbatim. Descriptive statistics use; noting patterns and themes, seeing possibilities, clustering, making metaphors, counting, comparing, partitioning variables and subsuming of particulars by more general categories to determine relationships between variables and to build logical chain of events (Kiboss, 2000; Leedy & Ormrod, 2010).

In interpreting the data, the impression or reflection of interviews, questionnaires, teaching, testing, and diaries/teacher's journal, secondary impression when reflecting on and reviewing the processing of data sources, summarizing triangulated lesson observation schedules, reflecting on documents, marking and summarizing achievement tests, and transcribing lesson processes as well as formal thematic analysis which involve the study of raw data, listing data categories, comparing and clustering categories, noting relationships between categories, subsuming categories, building logical chain of evidence, and linking understanding to research.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter present the results collected from the field. Data was collected using; Computer Assisted Statistical Text (CAST) where three Tests were issued (Pre Test, Test 1 and Test 2); student interview guide, teacher interview guide and also monitored and timed tests. The data collected was about, strategies used by learners with PD when learning mathematics and their performance in mathematics, relationship between students exposed to CBL and those without that exposure in their performance in mathematics, the relationship between the experienced low performance in mathematics subject in secondary schools for the physically disabled and the use or absence of use of CBL in those schools and finally challenges that students with physically disabled faced while using computers to do mathematics and strategies used to overcome the named challenges.

The study was conducted in three places; School 1 in Kisumu (n = 54 respondents), School 2 in Thika (n = 46 respondents) and School 3 in Mombasa (n = 33 respondents). The respondents from school 1 and school 2 were used as the treatment group part of the study (they used CBL method to learn mathematics) while the respondents from school 3 were used as control (they used traditional method to learn mathematics).The researcher used a sample of 133 respondents (n = 133), i.e. 128 students and 5 teachers, of which the treatment group constituted 96 students and 4 teachers while the control group constituted 32 students and 1 teacher. There was 100% return rate of the questionnaire items from the respondents that were involved in the study.

4.2 Instructional Strategies used in teaching Mathematics to learners with PD in Secondary Schools

The first objective was to establish the instructional strategies used in teaching mathematics to learners with PD in secondary schools in Kenya. The teaching of mathematics was evaluated using the performance since form one, identifying mode of teaching mathematics, interaction with computer, comparison of CBL with traditional method, whether CBL add value, basic information about CAST and information about student motivation.

4.2.1 Teaching of Mathematics

More than half of all the students, 72(55.6%) taught through traditional method performed fairly well. Majority of the students, 100 (77.8%) started interacting with computers while in form three; more than half 72 (55.6%) reported that CBL is easier to understand than traditional method and only 14 (11.1%) said that CBL is time consuming. More than three quarters of students 100 (77.8%) were in agreement that computers added value to students' motivation and achievement. The information is as indicated in Table 5.

Table 5: Response from Students on Teaching of Mathematics

Teaching of mathematics (n = 128)	Frequency (%)
Performance in mathematics since form one	
Above average	28 (22.2%)
Average	28 (22.2%)
Fair	72 (55.6%)
Mode of teaching mathematics in class since form one	
Use of chalk only / traditional method	128 (100%)
Use of computer	
Strategies used in teaching mathematics since form one	
Individualized education programme	128(100%)
Peer tutoring	76(60%)
Remedial teaching	85(66%)
Team teaching	96(75%)
Since when have you interacted with the use of computer in your learning	
Since form one	28 (21.9%)
Since form two	24 (18.8 %)
Since form three	76 (59.4 %)
Compare the use of computer based learning in mathematics with the teacher mode	
CBL is easier to understand	72 (55.6%)
CBL is time consuming	14 (11.1%)
CBL is encouraging	14 (11.1%)
CBL is not better than traditional method	28 (21.6%)
Does the use of computers add any value to your motivation and achievement	
Yes	100 (77.8%)
No	28 (22.2%)

The CAST included; success in using the software, problems faced during use, helpfulness of the software, ability of the software to perform the tasks, ability of the software to make students enjoy the class and whether the software added value during its use.

On the other hand, teachers in focus group discussions gave their views on the mode and strategies they use in teaching mathematics to students with PD.They mentioned chalk and talk (TI) as the main mode of teaching. They all express their eagerness to employ fully the use of CBL because in their view, it helps the learners with PD manipulate maths calculation with ease and speed especially if the input systems in the computers is adapted to suit learners with PD.They outlined the following as success in using CBL; accessibility of the software and ability of the software to make students enjoy calculations. All Teachers in focus group discussions echoed this statement;

> We majorly use the traditional method comprising of chalk and talk but we involved a number of strategies which include Individualized Educational Programme for slow learners, peer tutoring, remedial teaching and team teaching with our colleagues to enable the learners maximally capture the content and benefit fully in the teaching and learning process. But we have started the use of CBL and the learners are finding it exciting and much better than the chalk and talk method when fully used because it is self directing, faster and easier when input systems are adapted to suit the learners with PD.

In the qualitative data obtained from the teachers on the areas the computers were used to teach mathematics among the learners with PD, the following topics in mathematics were identified to be involved; graphics for 3 dimensional geometry, ICT lessons using KLB software in form one Mathematics, construction of loci and transformations in form four. For those who were not able to use computers to teach mathematics, some of the teachers in focus group discussion echoed this;

> Our inability to effectively use the technology is majorly due to lack of computer skills and lack of mathematics software because this one you are using in this research is still new and has not been used even with the learners with PD so far, your coming is God sent….. , we also have few computers and having more lessons in other subjects…. There is need also to modify the computers to suit learners with PD.

The teachers seem not to be using computers in teaching of mathematics among learners with PD due to several reasons that include lack of appropriate computer skills, inadequate computer hardware and software and tendency to be doing things the usual way among others.

These findings seem to be in agreement with that of Norton (1999) who in studying Brisbane teachers' responses to and beliefs about using computers for mathematics learning found that: (i) few secondary mathematics teachers used computers at least weekly; (ii) computers were considered equally or more effective than traditional instruction for doing calculations or providing basic skills practice; few teachers considered computers useful in developing conceptual understandings. The effective use of technology depends on the teacher. Teachers should use technology to enhance their students' learning opportunities by selecting or creating mathematical tasks that take advantage of what technology can do efficiently and well – graphing, visualizing, and computing (NCTM, 2000).

4.2.2 The use of Computer Assisted Statistical Text (CAST)

The respondents were requested to identify how well the lesson was, ability to access the software, enjoy the calculation using the software, enjoy the lesson, problems encountered during the lesson and the adequacy of computers. The respondents were in agreement that the software was helpful 96 (100%), it was up to task 85 (88.2%), it made students enjoy the class 86 (90%) and it added value to student's education 92 (95%) as indicated in table 6. However, the respondents suggested that the software need still be improved by modifying the input system to suit the learners with varied physical disabilities and also connecting the computers to the internet when using the software.

Table 6: Computer Assisted Statistical Text (CAST)

Computer Assisted Statistical Text (CAST) n = 96	Frequency (%)
Did the resource help or not?	
Yes	96 (100%)
No	
Was the resource up to the task?	
Yes	85 (88.2%)
No	11 (11.8%)
How could the resource be improved?	
Introducing new methods	
Connecting the computer to the internet	
Did the resource help the students to engage in and enjoy the class?	
Yes	86 (90%)
No	10 (10%)
Did the resource add value to students' education?	
Yes	92 (95%)
No	4 (5%)

Qualitative data was obtained from the teachers in focus group discussion on possible ways of improving existing ICT facilities and factors affecting the use of computers in teaching mathematics the learners with disability among others. The teachers in focus group discussion agreed that information technology was worthwhile for teaching and learning. However, several barriers to its effective implementation were identified and included hardware and software costs, and insufficient maintenance and technical support. The teachers also mentioned that large proportions of the teachers were at least prepared to use computers for teaching mathematics. Teachers were generally supportive of the idea of using computers to teach mathematics to learners with PD and that most were confident and comfortable enough to be in-serviced on computer applications.

4.3 Effects of CBL on Mathematics performance

The second objective of the study sought to find out the effects of CBL on students who are physically disabled (PH) in their performance in mathematics.

4.3.1 The Effects of Teaching Method on Mathematics performance among Learners with Physical Disabilities in Kenya

The school differences in performance of the pre-test test 1 and test 2 was sought during the study using both descriptive and analysis of variance. During the study the descriptive statistics was used to establish the difference in mean between the pre-test, CBL method and traditional method of teaching that was adopted. The Joyland and Joytown schools had both experimental and control treatments in test 1 and 2, while Mombasa school had only control treatment. There was difference in the pre-test scores of test 1 for Joyland (49.12), Joytown (52.82), compared to control in Mombasa (49.72) as shown in Table 7. This was replicated in test 2 with Joyland having a score of (53.54), Joytown (47.95), compared to control in Mombasa (49.72). This indicated that experimental treatment of pre-test scores for the three schools varied as indicated in Table 5 below.

Table 7: Pre-test Performance

School		Mean	Std. Deviation	N
Joyland	Experimental	51.33	12.653	52
	Control			
	Total	**51.33**	**12.653**	**52**
Joytown	Experimental	50.39	9.004	44
	Control			
	Total	**50.39**	**9.004**	**44**
Mombasa	Control	49.72	9.656	32
	Total	**49.72**	**9.656**	**32**
Total	Experimental	50.90	11.085	96
	Control	49.72	9.656	32
	Total	**50.60**	**10.721**	**128**

There was difference in the Test 1 experimental performance for treatment test 1 for Joyland (67.27), Joytown (69.18), compared to control in Mombasa (50.38) as shown in Table 8. This was replicated in test 2 with Joyland having a score of (56.81), Joytown (52.09), compared to control in Mombasa (50.38).

Table 8: Test 1 Performance

School		Mean	Std. Deviation	N
Joyland	Experimental	67.27	9.220	26
	Control	56.81	13.251	26
	Total	**62.04**	**12.476**	**52**
Joytown	Experimental	69.18	11.027	22
	Control	52.09	8.954	22
	Total	**60.64**	**13.163**	**44**
Mombasa	Control	50.38	9.217	32
	Total	50.38	9.217	32
Total	Experimental	68.15	10.023	48
	Control	52.94	10.863	80
	Total	**58.64**	**12.854**	**128**

However on the treatment the performance of experimental group was 62.04 in Joyland, with 60.64 in Joytown and 50.38 in Mombasa. From the findings the performance of experimental group was higher compared to the control group in the three schools. This indicated that Test 1 scores for the three schools were varied.

There was difference in the Test 2 experimental performance for treatment test 1 for Joyland (60.12), Joytown (59.50), compared to control in Mombasa (53.88) as shown in Table 9. This was replicated in test 2 with Joyland having a score of (68.58), Joytown (67.91), compared to control in Mombasa (53.88). However on the treatment the performance of experimental group was 64.35 in Joyland, with 63.7 in Joytown and control 53.88 in Mombasa. From the findings the performance of experimental group was higher compared to the control group in the three schools. This indicated that Test 2 scores for the three schools were varied.

Table 9: Test 2 Performance

School		Mean	Std. Deviation	N
Joyland	Experimental	68.58	14.400	26
	Control	60.12	7.654	26
	Total	**64.35**	**12.191**	**52**
Joytown	Experimental	67.91	9.451	22
	Control	59.50	7.999	22
	Total	**63.70**	**9.641**	**44**
Mombasa	Control	53.88	8.842	32
	Total	**53.88**	**8.842**	**32**
Total	Experimental	68.27	12.261	48
	Control	57.45	8.655	80
	Total	**61.51**	**11.397**	**128**

4.3.2 Difference in Mathematics Performance

There was a difference in the scores of pre-test, test 1 and test 2 among the sampled schools. The mean score performance in mathematics of pretest at Joyland was 51.33, Joytown (50.39) and Mombasa (49.72). Test 1 comprised of a mean score of 62.04 Joyland, 60.64 Joytown and 50.38 Mombasa. However, test 2 of Joyland had a mean score performance of 64.35; Joytown had 63.7 and Mombasa 53.88. These findings indicated that the performance of mathematics in the three schools varied, with Mombasa recording the lowest followed by Joytown and finally Joyland. This indicated that experimental treatment of pre-test scores for the three schools varied.

Table 10: Difference in Mathematics Performance

		N	Mean	Std. Deviation	Std. Error
Pre-test	Joyland	52	51.33	12.653	1.755
	Joytown	44	50.39	9.004	1.357
	Mombasa	32	49.72	9.656	1.707
	Total	**128**	**50.60**	**10.721**	**.948**
Test 1	Joyland	52	62.04	12.476	1.730
	Joytown	44	60.64	13.163	1.984
	Mombasa	32	50.38	9.217	1.629
	Total	**128**	**58.64**	**12.854**	**1.136**
Test 2	Joyland	52	64.35	12.191	1.691
	Joytown	44	63.70	9.641	1.454
	Mombasa	32	53.88	8.842	1.563
	Total	**128**	**61.51**	**11.397**	**1.007**

From the study the lowest students' performance in Mathematics was during the pre-test in the three schools. However the highest students' academic achievement in Mathematics was during the adoption of CBL method. On average the adoption of traditional method after subjecting the students to the CBL method had an average mean. This mean score was higher than that of the pre-test but lower than that of CBL method.

4.3.3 ANOVA on Difference in Mathematics Performance

In occasions where the data had more than one dependent continuous variable or more than two values across the categorical independent variables, an Analysis of Variance (ANOVA) was used to compare the performance in mathematics in sampled schools, with respect to treatment, test one and two. A one-way analysis of variance was conducted to explore the variation on the performance of schools with respect to treatment as shown in (Table 11).

There was a statistically significant difference in performance of test 1 [F (1, 125) =10.27] and test 2[F (1, 125) =11.14]. However, there was no significant difference in pre-test ($p>0.05$). Since the effects of test 1 and 1 was found to be significant, it implies that their means differ more than would be expected by chance alone and despite reaching statistical significance, the actual difference in mean scores between the groups was quite small. The findings showed that when the pre-test exam was given the performances of the three schools were not different as compared to when test 1 and two was issued. This indicated that the influence of CBL method was significant as well as traditional method subjected after the CBL.

Table 11: Analysis of Variance on students' academic achievement in Mathematics

		Sum of Squares	df	Mean Square	F	Sig.
Pre-test	Between Groups	54.337	2	27.168	.234	.792
	Within Groups	14542.343	125	116.339		
	Total	14596.680	127			
Test 1	Between Groups	2961.864	2	1480.932	10.272	.000
	Within Groups	18021.605	125	144.173		
	Total	20983.469	127			
Test 2	Between Groups	2495.564	2	1247.782	11.141	.000
	Within Groups	14000.428	125	112.003		
	Total	16495.992	127			

There was a statistically significant difference at the $p<.05$ level in CBL method. Since the effects of CBL method was found to be significant, it implies that the means differ more than would be expected by chance alone and despite reaching statistical significance, the actual difference in mean scores between the groups was quite small. Since the effects of traditional method were found to be not significant, it implies that the means do not differ much. Thus, the adoption of CBL methods influenced positively the students' performance in Mathematics among the learners with physical disabilities.

The current study found significant difference in final exam scores of students receiving traditional instruction and those receiving CBL. This agreed with Fletcher, Hawley, and Piele, (1990) that a third and fifth graders in Canada who used the computer to supplement classroom instruction scored significantly higher on a standard test of mathematics achievement than those receiving conventional instruction. Also concurs with Olusi, (2008) that the mathematical achievement of high school students in Nigeria who were randomly assigned to computer-assisted instruction or traditional instruction revealed a significantly higher mean for the computer-assisted group.

The findings support Bialo and Sivin-Kachala, (1996) that educational technology had a positive impact on achievement for all subject areas from preschool through higher education. The achievement of students using computer-based instruction was significantly related to the amount of technology-related training the teachers had received and whether the technology was being used appropriately. It concurs with Cotton, (2000) that a computer-based learning and student outcomes concluded that computer-assisted instruction as a supplement to traditional instruction produced higher achievement than traditional instruction alone, but when computer-assisted instruction alone was compared to traditional instruction.

4.3.4 Post Hoc Tests (LSD)

The Post Hoc Tests (LSD) multiple comparisons were used to establish the effect of teaching method as summarized in table 12. There was a positive relationship between Test 1 for Joyland and Mombasa as well as Joytown and Mombasa. The difference also showed that a negative significant relation existed in test 1 for Mombasa and Joyland and Joytown.

Table 12: Post Hoc Tests (LSD) Multiple Comparisons

Dependent Variable	(I) School	(J) School	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Pre-test	Joyland	Joytown	.941	2.209	.671	-3.43	5.31
		Mombasa	1.608	2.423	.508	-3.19	6.40
	Joytown	Joyland	-.941	2.209	.671	-5.31	3.43
		Mombasa	.668	2.506	.790	-4.29	5.63
	Mombasa	Joyland	-1.608	2.423	.508	-6.40	3.19
		Joytown	-.668	2.506	.790	-5.63	4.29
Test 1	Joyland	Joytown	1.402	2.460	.570	-3.47	6.27
		Mombasa	11.663*	2.698	.000	6.32	17.00
	Joytown	Joyland	-1.402	2.460	.570	-6.27	3.47
		Mombasa	10.261*	2.790	.000	4.74	15.78
	Mombasa	Joyland	-11.663*	2.698	.000	-17.00	-6.32
		Joytown	-10.261*	2.790	.000	-15.78	-4.74
Test 2	Joyland	Joytown	.642	2.168	.768	-3.65	4.93
		Mombasa	10.471*	2.378	.000	5.77	15.18
	Joytown	Joyland	-.642	2.168	.768	-4.93	3.65
		Mombasa	9.830*	2.459	.000	4.96	14.70
	Mombasa	Joyland	-10.471*	2.378	.000	-15.18	-5.77
		Joytown	-9.830*	2.459	.000	-14.70	-4.96

*. The mean difference is significant at the 0.05 level.

For test 2 a negative relationship existed between Joyland and Mombasa schools.The same was also experience between Mombasa on one hand and Joyland and Joytown on the other hand. This implies that the adoption of CBL method affect the students' academic achievement in Mathematics among the physically disabled. The CBL method was found to be significant in Joytown School as Compared to Mombasa. There was negatively significant difference in the use of traditional method between Mombasa and Joyland schools. The conclusion of the current study agrees with the previous results as it found significant difference in the mathematical performance of students that use CBL and those using traditional mode. The mean score of the computer-assisted group was higher. The findings agree with Kulik, (2002) and Liao, (2007) that

that computer-assisted instruction produced higher achievement, especially when combined with and not replacing traditional instruction.

4.3.5 Relationship between the students exposed to CBL and those without that exposure in their performance in mathematics

The performance was measured based on test results of pre-test, CBL method and traditional method of learning.

4.3.5.1 Relationship between CBL method and pre-test performance

Pearson's r was used to check on the direction of relationship, whether positive or negative, established the strength of relationship and either to accept or reject the null hypothesis. A linear regression analysis was used to explore interrelationship among the variables using a model. R^2 represents the values of linear correlation coefficients between the predictors used in the model. From the model, ($R^2 = .436$) shows that all the predictor account for 43.6% variation in pre-test performance (Table 13). The change statistics was used to test whether the change in adjusted R^2 is significant using the F ratio. The model caused adjusted R^2 to change from zero to .436 and this change gave rise to an F ratio of 97.23, which is significant at a probability of .05.

Table 13: Model Summary on pre-test performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.660[a]	.436	.431	9.26006	.436	97.234	1	126	.000

a. Predictors: (Constant), CBL Methods

The analysis of variance was used to test whether the model could significantly fit in predicting the outcome than using the mean as shown in (Table 14). The F- ratio represents the ratio of improvement in prediction that results from fitting the model, relative to the inaccuracy that exists in the model. The F- ratio was 97.23 which is likely to happen by chance and was significant (P<.05). The model significantly improved the ability to predict the pre-test performance in mathematics. Thus the model was significant leading to rejection of the null hypotheses. This represented the effect size of the regression model and was significant with a p-value of 0.000.

Table 14: Analysis of Variance on CBL Methods

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8337.668	1	8337.668	97.234	.000[b]
	Residual	10804.332	126	85.749		
	Total	**19142.000**	**127**			

a. Dependent Variable: pre-test performance
b. Predictors: (Constant), CBL Methods

Table 14 shows the estimates of β values and gives an individual contribution of predictor to the model. The β value explains about the relationship between CBL method and predictor. The positive β values indicate the positive relationship that exists between the predictors and the outcome. The β value for CBL method had a positive coefficient thus positive relationship with pre-test performance.

Table 15: Coefficients of pre-test performance

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	26.381	3.964		6.656	.000
	CBL	.756	.077	.660	9.861	.000

a. Dependent Variable: Pre-test performance

The regression results in Table. 15 show that each of the predicted parameters in relation to the independent factor was significant; $\beta 1= 0.756$ ($p < 0.05$) which implies that we reject the null hypothesis stating that there is no significant relationship between CBL method and pre-test performance. This indicates that for each unit increase in the, CBL method there is 0.756 units increase in pre-test performance. Also the influence of CBL method is shown by the t-test value of 9.86 which implies that the effect surpasses that of the error by over 9.86 times. The following Regression Equation was arrived at;

$y=26.381+0.756x$

Where *y* is the dependent variable which the performance.

4.3.5.2 Relationship between traditional method and pre-test performance

From the model, (R^2 = .569) shows that the predictor account for 56.5% variation in pre-test performance (Table 16). The change statistics was used to test whether the change in adjusted R^2 is significant using the F ratio. The model caused adjusted R^2 to change from zero to .569 and this change gave rise to an F ratio of 166.09, which is significant at a probability of .05.

Table 16: Model Summary on pre-test performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.754[a]	.569	.565	7.06914	.569	166.093	1	126	.000

a. Predictors: (Constant), Traditional Method

The analysis of variance was used to test whether the model could significantly fit in predicting the outcome than using the mean as shown in (Table 17). The F- ratio represents the ratio of improvement in prediction that results from fitting the model, relative to the inaccuracy that exists in the model. The F- ratio was 166.09 which is likely to happen by chance and was significant ($P<.05$). The model significantly improved the ability to predict the pre-test performance in mathematics. Thus the model was significant leading to rejection of the null hypotheses. This represented the effect size of the regression model and was significant with a p-value of 0.000.

Table 17: Analysis of Variance on pre-test performance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8300.119	1	8300.119	166.093	.000[b]
	Residual	6296.560	126	49.973		
	Total	**14596.680**	**127**			

a. Dependent Variable: Pre test

b. Predictors: (Constant), Traditional

Table 17 shows the estimates of β values and gives an individual contribution of predictor to the model. The β value explains about the relationship between CBL method and predictor. The positive β values indicate the positive relationship that exists between the predictors and the outcome. The β value for traditional method had a positive coefficient thus positive relationship with pre-test performance.

Table 18: Coefficients of pre-test performance

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	7.165	3.428		2.090	.039
Traditional	.782	.061	.754	12.888	.000

a. Dependent Variable: Pre test

The regression results in Table 18 show that each of the predicted parameters in relation to the independent factor was significant; β1= 0.782 ($p < 0.05$) which implies that we reject the null hypothesis stating that there is no significant relationship between traditional method and pre-test performance. This indicates that for each unit increase in the, traditional method there is 0.782 units increase in pre-test performance. Also the influence of traditional method is shown by the t-test value of 12.89 which implies that the effect of traditional method surpasses that of the error by over 12.89 times.

4.3.5.3 Relationship between traditional method and CBL method

A linear regression analysis was used to explore interrelationship among the variables using a model. R^2 represents the values of linear correlation coefficients between the predictors used in the model. From the model, (R^2 = .792) shows that all the predictor account for 79.2% variation CBL method (Table 19). The change statistics was used to test whether the change in adjusted R^2 is significant using the F ratio. The model caused adjusted R^2 to change from zero to .625 and this change gave rise to an F ratio of 212.69, which is significant at a probability of .05.

Table 19: Model Summary on pre-test performance

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df 1	df2	Sig. F Change
1	.792[a]	.628	.625	7.51782	.628	212.691	1	126	.000

a. Predictors: (Constant), Traditional

The analysis of variance was used to test whether the model could significantly fit in predicting the outcome than using the mean as shown in (Table 20). The F- ratio represents the ratio of improvement in prediction that results from fitting the model, relative to the inaccuracy that exists in the model. The F- ratio was 212.69 which is likely to happen by chance and was significant (P<.05). The model significantly improved the ability to predict the CBL method. Thus the model was significant leading to rejection of the null hypotheses.

Table 20: Analysis of Variance on CBL Methods

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12020.783	1	12020.783	212.691	.000[b]
	Residual	7121.217	126	56.518		
	Total	**19142.000**	**127**			

a. Dependent Variable: CBL Methods

b. Predictors: (Constant), Traditional

Table 21 shows the estimates of β values and gives an individual contribution of predictor to the model. The β value explains about the relationship between traditional method and CBL method. The positive β values indicate the positive relationship that exists between the predictors and the outcome. The β value for traditional method had a positive coefficient hence positive relationship with CBL method.

Table 21: Coefficient s of pre-test performance

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	12.351	3.645		3.388	.001
	Traditional	.941	.065	.792	14.584	.000

a. Dependent Variable: CBL Methods

The regression results in Table 21 show that each of the predicted parameters in relation to the independent factor was significant; β3= 0.941 ($p < 0.05$) which implies that we reject the null hypothesis stating that there is no significant relationship between traditional method and CBL method. This indicates that for each unit increase in the, traditional method there is 0.941 units increase in CBL method. Also the influence of traditional method is shown by the t-test value of 14.58 which implies that the effect of traditional method surpasses that of the error by over 14.58 times.

The research on the effects of computer based use on the mathematical learning of students of various ages and ability levels suggests that computer-assisted instruction as a supplement to traditional classroom instruction is more effective than traditional instruction alone (Brothen and Wambach, 2000; Butzin, 2000; McSweeney, 2003; Nguyen, 2002; Olusi, 2008). The test scores of low-achieving students were higher with computer-assisted instruction combined with traditional instruction than with traditional instruction alone, (Hannafin and Foshay, 2008). The findings agree with Fitzgerald and Koury, (1996) that students with mild and moderate cognitive learning disabilities learned as well or better with computer-assisted instruction than without it. The figure 3 below gave a graphical representation of the distribution of students' score in mathematics for both cycle 1 (control group) and cycle 2 (treatment group) results.

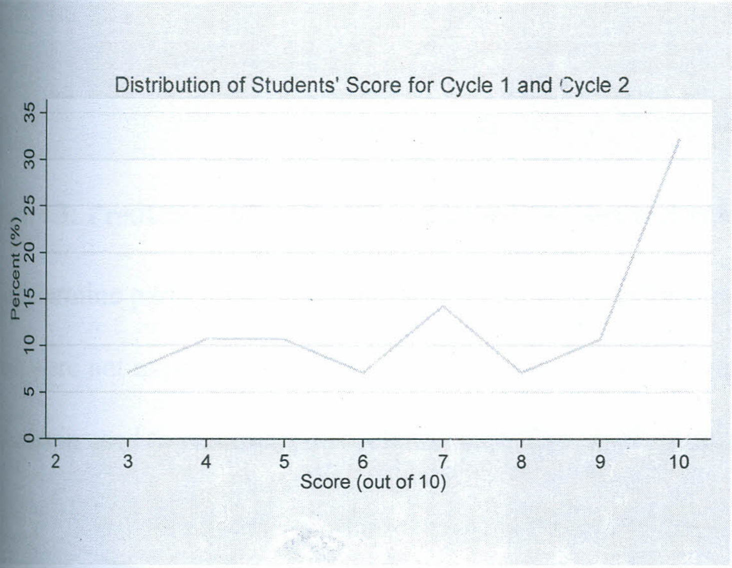


Figure 2: Distribution of students' score for cycle 1 and cycle 2

Most students scored better in their tests (i.e. scores between 9 to 10 showed higher percentages, between 11% to 32%). More specifically, to determine the relationship between performance in mathematics and the students who were exposed to CBL from those who were not exposed to the same, figure 4 below on regression of the best fit was used to represent this relationship. The performance in mathematics was the fitted values of the response variable in the regression model above. The graph showed a positive correlation.

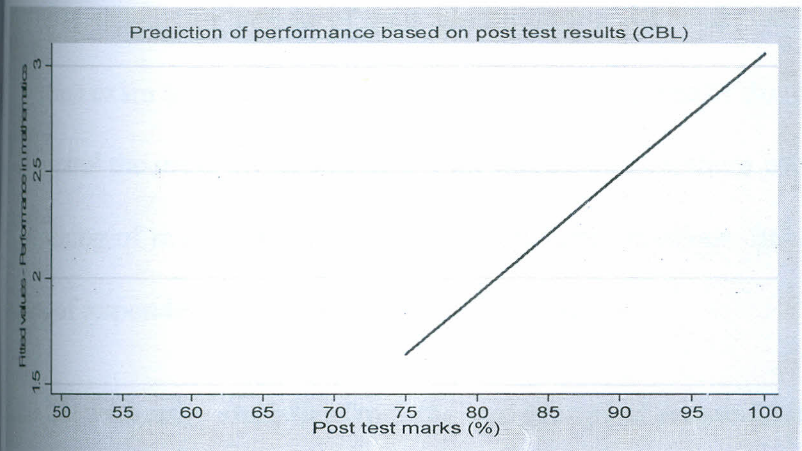


Figure 3: Prediction of performance based on post test results (CBL)

To determine particularly the relationship between performance in mathematics and the students who were not exposed to CBL (based on pre-test result), figure 5 below indicating regression fit was again used to represent this relationship. The graph showed a negative correlation.

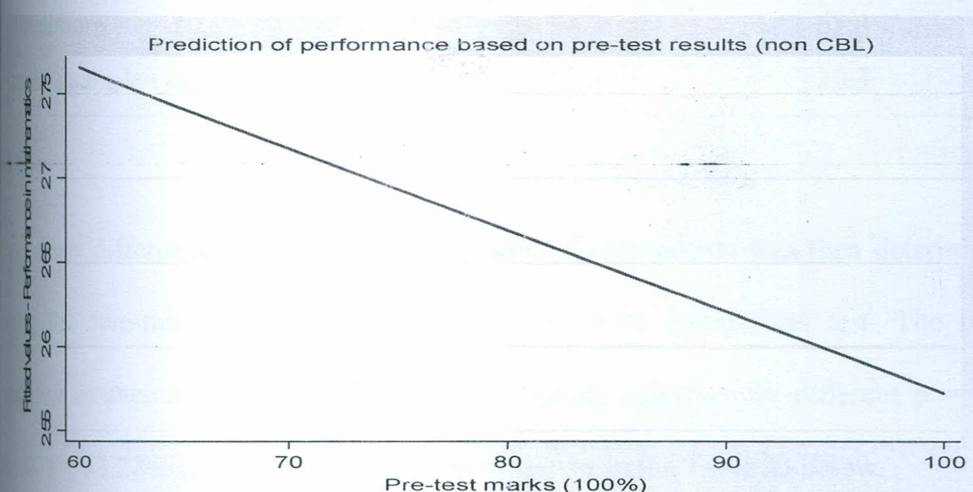


Figure 4: Prediction of performance based on pre - test results (non CBL)

The researcher then regrouped the respondents in two groups in both treatment schools, the group 2 students were composed of students who were previously on traditional method of learning mathematics but now exposed to CBL in their learning while group 1 respondents were those who were on CBL previously but now on traditional method. These two cohorts of students were then taught for period of four weeks during the study period and then made to sit an evaluation exam at the end of that time period. The purpose of this counter balance design was to help control the order effect and determine more clearly if there was any significant difference in the teaching of mathematics using the two different methods. Summary statistics from the two groups of respondents are indicated in Table 22 below.

Table 22: Summary statistics from the two groups of respondents

Summary statistics	Group2	Group1
N	48	48
Mean	89.8	51.6
Median	90	51.4
Standard deviation	4.6	11.7
Minimum	85	40
Maximum	94.3	63.3
Inter-quantile range	9.3	23.3

The mean difference between the two groups of respondents was then determined statistically using the two-tailed t-test for the two sample mean comparison test. The two methods of teaching mathematics was found to be statistically significantly different $p = 0.0186$, 95%CI (13.0789, 63.2703). The result for this test is shown in the Table 23 below.

Table 23: **Pre-test counter balance design**

	Statistic	Test	N	mean	SE	t	p-value	95%	C.I
Group 2			48	89.7619	2.6832			78.2170	101.3068
Group 1			48	51.5873	6.7362			22.6037	80.5709
Difference	Mean Diff	Two tail t-test		38.1746	7.2509	5.265	0.0186	13.0789	63.2703

The test therefore asserted that the students who were exposed to CBL in the teaching of mathematics significantly performed better than their counterparts who were taught by the traditional method. The findings concur with Cotton, (2000) and Hannafin and Foshay, (2008) that Computer-based use allows students to work at their own pace at a time and place of their choosing from any computer with internet access. Students receive immediate feedback on assignments and can revisit topics until they have mastered the content. They may have access to videos, guided practice problems, and online tutoring. The software can provide each student with an individualized study plan. Teachers can create quizzes and tests to be delivered and graded by the software. It also provides the instructor with data to show how students are progressing in the course (Ford and Klicka, 1998).

4.3.6 Comparison of the results for group1 and group 2

The researcher then grouped the respondents from the treatment arm of the study into two groups; group 1 and group 2.They were then taught for a period of time using the two different methods of learning and given three series of tests at the end of that period. The tests were then administered to students in groups 1 and 2, where group1 were students who have been using CBL in learning mathematics while group 2 were students who have been using traditional method in learning mathematics. The figure 6 below shows the test results taken through tests 1, 2 and 3 for both groups of students. Students who have been using CBL throughout the learning period posted higher results (test1 = 90%, test 2 = 94% and test3 = 88%) in all the three tests compared to their counterparts who have been using traditional method.

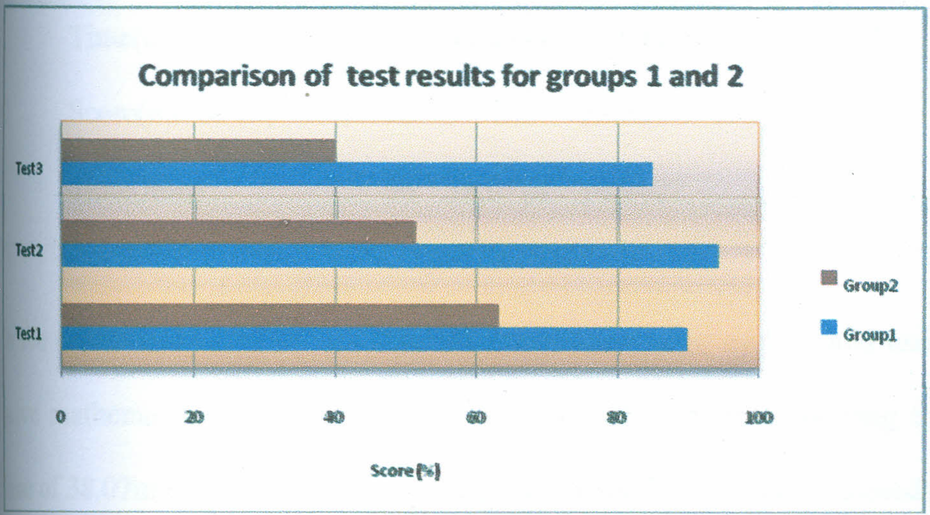


Figure 5: Comparison of the results for group 1 and group 2

4.3.7 Comparison of the results for cycle1 (control group) and cycle2 (treatment group)

More tests were further administered to all respondents under study through cycle 1 (comprising the students in the control group) and cycle 2 (comprising the students in the treatment group) in order to compare the speed taken in solving mathematical problems alongside measuring achievement. In cycle 1, students used the traditional method to solve mathematical problems while in cycle 2 they used the CBL method.

Table 24: Summary statistics for test results in cycle 1 and cycle 2

Cycle	Variable	N	Mean	Standard deviation	Min	Max
1	Score(out of 10)	32	7.5714	2.3440	3	10
	Time(min)	32	40.8571	13.9497	20	60
2	Score(out of 10)	96	7.1429	2.6561	3	10
	Time(min)	96	38.0714	14.4407	21	60

In the figure 6 below, the students who took the test in cycle 2 and used the CBL method to solve mathematical problems showed slightly higher speed in solving the problems, (average time of 38.07min) compared to the traditional method where they required slightly longer time to solve the problems, (average time of 40.88min).

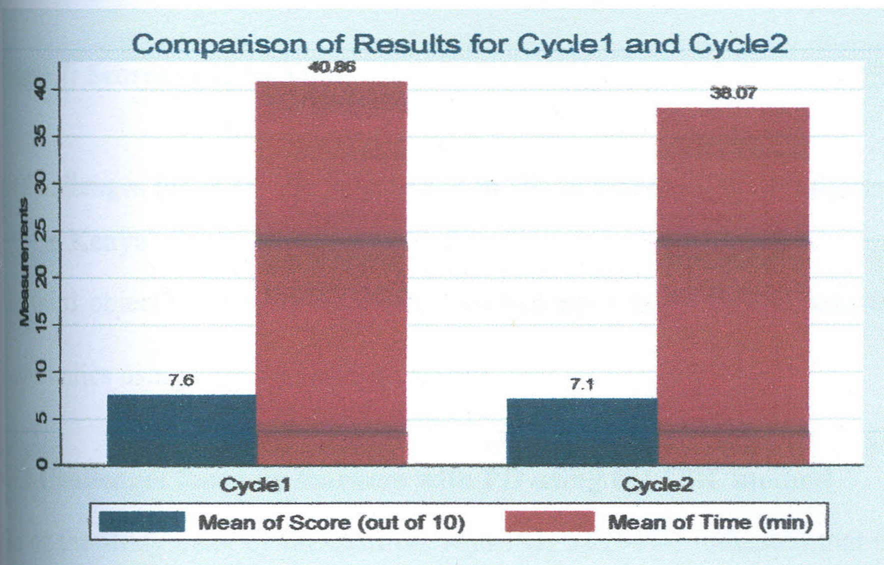


Figure 6: Cycle 1 and Cycle 2 Results Comparison

Figure 8 below was used to check how time taken to solve the mathematical problems relates with the scores (test results). Higher scores were attained with less time taken in solving the mathematical problems in both cycle 1 and cycle 2.

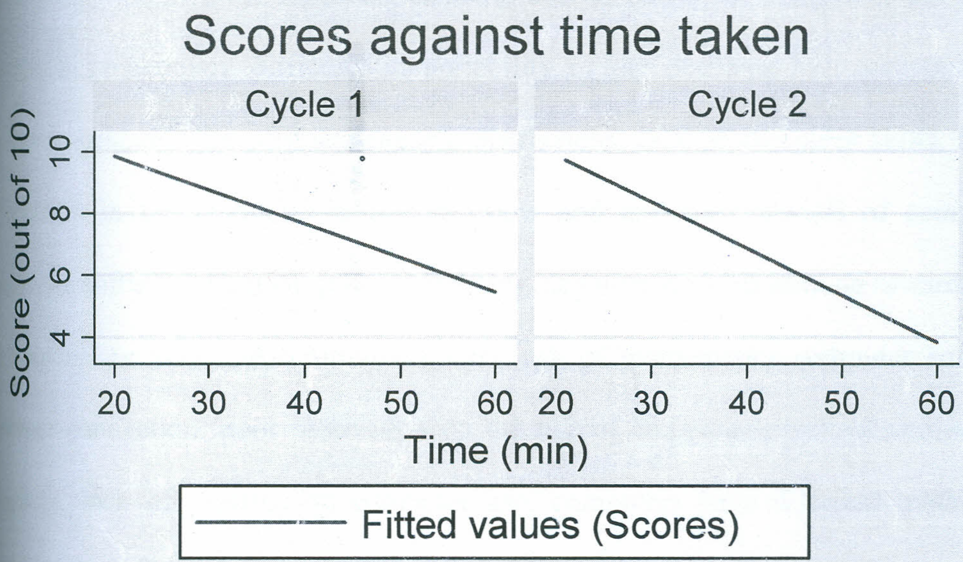


Figure 7: Scores against Time

4.4 Challenges faced by the learners with PD in learning Mathematics using CBL methods in Kenya

The third objective was to establish the challenges faced by the learners with PD in learning mathematics using CBL methods in Kenya.

4.4.1 Challenges faced by learners with PD using the CBL method

During the study most of the learners with PD, 52 (54%) indicated that they had problems with using the CBL method in learning mathematics using CBL. On the other hand, 46 (45%) had no problem. Qualitative data was sought from the learner's interviews on factors hindering learners with PD using computers and the problems arising from the use of computers to learn mathematics.

As regards the factors that affected the use of computers in learning mathematics, students in all interviews expressed the following challenges as hindering their effective use of CBL; frequent computer breakdown, difficulty in portability of the desktops into mathematics classrooms, computers make a lot of noise causing distractions, lack of computer skills, lack of access to computers in the computer laboratory, slow and out-dated models of computers, out-dated computer software, frequent power blackouts, negative students attitude towards computers, few computers are available limiting learners, lack of mathematics computer soft wares, lack of internet connection, poor motivation on the use of computers, lack of computer-mathematics teachers, lack of practice on computer use, computers have different mathematics symbols different from those found in textbooks, use of computers requires more time and hence it wastes a lot of time and lack of guidance on the use of computers.

All students interviewed echoed the following statement;

> The input systems in the used computers are not adopted to suit the learners with physical disabilities. I also have a lot of challenges in trying to understand proper use of the software installed and time given during the class lessons is not adequate. Also we share the few useable computers with my classmates which are in most cases not enough as the case should be.

In terms of problems arising from using computers to learn mathematics, some of the students interviewed underscored the following: slow typing speed on the computer keyboard that is not adapted to suit learners with PD, complicated functions (formulae) in the computers, lack of training on computer use, computer breakdown while using them to learn mathematics, straining eyes on bright light from computer screens, computer 'hang-ups' while using them, computer errors as a result of wrong entries, computer viruses, power blackouts, computer vocabulary, threats from teachers on the use of computers-take precaution because computers are expensive, fear of computers, lack of confidence towards computer use, lack of enough space for all students especially with wheelchairs and crutches, lack of adequate mathematics-computer software, unwilling teachers to use computers, lack of computer facilities, lack of learning programmes whereby there is no time schedules on the use of computers, and change of computer passwords by other students.

In summary, most of the students interviewed though seemingly enthusiastic about using computers for learning mathematics, were faced with several challenges which included, frequent power blackouts, lack of computer skills and inadequate mathematics software among others. This made some of them to opt for alternative instruments for learning mathematics such as the use of scientific calculators, mathematical tables and geometrical set. Students were willing to use computers to learn mathematics much more if the concerns they raised like providing computers adapted to suit their PD condition were put in place. These encouraging factors and the relative rankings are similar to those reported by computer users in Zammit's (1992) study which were; access to computers, the availability of software, self-motivation to stay up-to-date, the need for students to learn to use technology, and a supportive computer coordinator (teacher) were the five top-ranked (researcher-supplied) categories.

The solutions to these problems included adding more computers to enable most of the learners access computers, buying more software, activating the site in discs and flash disks, going through the work being done and installing the program before lesson begin to avoid time consuming. They should be practicing the use of computers everyday and consulting others, creating enough space to draw the graphs by giving students procedure during the lesson and keeping the computers free from virus, buying more computers, having all software required and students should ask the teacher for help. However, the study particularly found out that there is need to provide computers that were adapted to suit the learners with PD like modified input systems to bridge manipulation challenges.

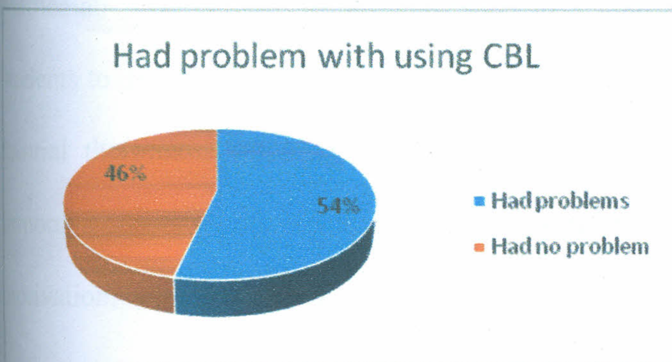


Figure 8: Problems with using the CBL method

This study does not concur with some of the research on the effects of CBL on the mathematical learning of students of various ages and ability levels. For example, students in kindergarten through fifth grade in Project CHILD classrooms, which integrate computer stations with hands-on exploratory projects and direct instruction, had higher test scores than students in traditional classrooms (Butzin, 2000).

In order for students to receive the maximum benefit from using a computer learning system, schools should provide instruction in how to use the system. These findings agree with (Engelbrecht & Harding, 2005; Jacobson, 2006 and Smith and Ferguson, 2004) that researchers have discovered a high degree of frustration among students and teachers in communicating with mathematical symbols. Learners need to learn how to enter mathematical notation. A student may have the correct answer on paper but the computer will not accept it as correct if the answer is entered improperly. They also need to know how to use the tutorial features and the study plan to improve their learning. Some students attempt the graded assignments without first working the tutorials and become discouraged when they earn low scores. Students should also be taught how to monitor their progress in the course using the grade book.

Mathematics courseware is software used in a computer lab or in a classroom that pre-tests students to determine their specific mathematics needs. It then provides customized lessons and tutorial that focus on those needs. The mathematics courseware program has resulted in important benefit, improved student self-esteem (Holland, 2002). This leads to student motivation, willingness to use computers in learning mathematics and an overall good performance in mathematics at the end of the course and further career developments.

Qualitative data obtained from the teachers focus group discussions required that they give information on level of consultation by the administration in acquisition of teaching and learning materials, possible ways of improving existing ICT facilities and factors affecting the use of Computers to teach mathematics among others. In response, teachers in focus group discussion indicated the following as points of consultation: They are consulted on what type and quality of computer software to buy, when making requisition of computer software, textbooks and computer accessories, they are members of the tendering committee and they give estimates of the prices of computer software in the market.

For those teachers in focus group discussion who were not using computers to teach mathematics, they indicated the following as their reasons for not doing so; most mathematics teachers lack computer skills, lack of mathematics software, few computers, having more lessons in other subjects, and the computer laboratory is small and cannot accommodate all students with PD in one shift. Over and above, the respondent teachers in interviewed indicated the following as factors affecting use of computers to teach mathematics: unmodified computers to suit learners with PD, lack of mathematics software, power blackouts, few computers, lack of enough time to prepare for computer mathematics lessons, syllabus is not yet integrated with use of computers, lack of computer skills by mathematics teachers, all classes do not have sockets to use with computers, lack of time schedule in the laboratory for mathematics lessons, poor internet connectivity and workload- more lessons for mathematics teachers hence they are biased to the second subject.

In conclusion, most of the teachers in focus group discussion seem not to be using computers in teaching of mathematics due to several reasons that include lack of appropriate computer skills, inadequate computer hardware and software and tendency to be doing things the usual way among others. This finding seems to be in agreement with that of Norton (1999) who in studying Brisbane teachers' responses to and beliefs about using computers for mathematics learning found that: (i) few secondary mathematics teachers used computers at least weekly; (ii) computers were considered equally or more effective than traditional instruction for doing calculations or providing basic skills practice; few teachers considered computers useful in developing conceptual understandings. The effective use of technology depends on the teacher. Teachers should use technology to enhance their students' learning opportunities by selecting or creating mathematical tasks that take advantage of what technology can do efficiently and well – graphing, visualizing, and computing (NCTM, 2000).

In the U.S., Smerdon, *et al.,* (2000), found in their study that only half of the public school teachers who had computers available in their schools used them for classroom teaching and learning. The teachers' perceptions of the barriers to computer and Internet use for instruction were also examined. Most frequently, the teachers in focus group discussion reported lack of release time to learn how to use computers, lack of time in the daily schedule for students to use computers in class and insufficient numbers of computers as the major barriers. These findings were quite eminent in this study.

This agree with Hadley and Sheingold (1993) who reported a similar, related set of barriers to computer use that teachers identified in this study which included: lack of appropriate software or information about it; teachers' self-doubts, lack of interest or knowledge about computers; inadequate numbers of computers; and lack of maintenance, support, advice, and upkeep. In a fairly recent large Australian study, Finger *et al.,* (1999) found that most of the participating teachers had very high levels of basic computer skills, with a much lower proportion reporting advanced skills. In this study however, the main challenge as revealed is teachers' lack of adequate training on the teaching of learners with PD and ill preparedness on the use of computers to teach mathematics to this category of students.

4.4.2 Strategies adopted by learners with physically disabled to overcome the challenges in learning mathematics using CBL Methods

This was obtained from the recommendations given by the students as summarized in Table 28. From the findings 23 (24%) of the students agreed that computer based learning is good because it made the lesson interesting, it avoided boredom as indicated in Table 25 below.

Table 25: Recommendations on the steps to be taken to improve the teaching and learning of mathematics

	Frequency	Percent	Cumulative Percent
Computer based learning is good because it makes the lesson to be interesting and is not easy to get bored	23	24.0	24.0
Encouraging teachers to use CBL to teach students math's than using the traditional system	12	12.5	36.5
Encouraging the frequency use of computer in schools for learning.	7	7.3	43.8
Having weekly lessons of CBL should be incorporated in curriculum	8	8.3	52.1
Use of CBL should also be introduced to other subjects	23	24.0	76.0
Its gives teachers and students easy time and also students solve problems from the computer as fast as possible	8	8.3	84.4
Teachers of mathematics should guide the students on how to perform calculations during computer based learning	1	1.0	85.4
Students should inquire the use of computer when doing math's as ~~this~~ will increase performance and interest in maths	7	7.3	92.7
CBL should be used continuously because it takes less time to complete mathematics exercises.	7	7.3	100.0
	96	100.0	

From the study, 7 (7.3%) students recommended the frequency use of computer in schools for learning as it increased their performance and interest. Its use should be continued because it took them less time to complete tasks. Also 8 (8.3%) schools should be encouraged more and at least have weekly lessons of CBL. The teachers and students should be given more time to understand and get acquainted with the use of projectors. This will enable students to get questions and answers from the computer as fast as possible.

From the study 12 (12.5%) agreed that they encourage teachers to use CBL to teach students math's than using the traditional system. Finally, some of the respondents identify teachers of mathematics should guide the students on how to perform calculations using computer based use. The study recommends CBL related accessories should be made available in order to ensure that sustainable computer projects initiated. Teachers should be trained on innovative uses of computers in teaching and learning so that they become competent in using them.

Both pre and in service teachers should be trained in computer literacy. Government should have clear guidelines regarding the design of standard curriculum focusing on education software and availing them be scholars for purposes of teaching and learning. The Government in liaison with other stakeholders should implement policies relating to facilitation of universal access to ICT infrastructure, i.e. power equipment and improved connectivity in all institutions of learning. Government incentives like good remuneration as this will make significant efforts in CBL motivation.

Qualitative data obtained from teachers during the interviews on possible ways of improving existing computers to help in the teaching of mathematics to learners with PD highlighted the following: input systems in the computers should be modified to suit the learners with PD, computers should be regularly serviced, purchasing all computer accessories, networking the existing computers, expanding the computer laboratory, use of projectors for large classes, improving on the speed of processing of the current computers by upgrading their memory, installing mathematics-computer software on the existing computers, timetabling to include all classes, time schedule to accommodate all forms, purchasing more computers, constructing power point screens in classrooms and updating the antivirus regularly.

The same teachers therefore suggested the following as the possible solutions to the stated factors as a remedial mechanism: all subjects to be allocated time to use computers in the computer laboratory, all teachers of mathematics teaching in schools for learners with PD be provided with seminars and in-servicing on the current trends and methodologies of teaching learners with PD,all teachers of mathematics to be in-serviced on ICT-Skills, improve computer infrastructure, purchase mathematics software, revise current syllabus to accommodate use of computers to teach mathematics, downloading materials for mathematics from the internet, power backup to be installed in school such as a generator and UPS (Uninterruptible Power Supply), installation of power sockets in every mathematics class, sponsorships by computer for schools by making computers affordable to more schools, employ more mathematics teachers with computer skills and the internet connectivity should be made cheap and affordable.

All the teachers in the focus group discussion further echoed the following as the possible solutions on the challenges; need to demystify the complexity of the subject among the learners with PD by using CBL in curriculum to illustrate, demonstrate and illuminate abstract concepts, CBL should be integrated so that teachers and students can use to teach and learn mathematics, replicating the CBL to other subjects other than mathematics, CBL software for teaching mathematics should be designed in line with the teachers and learners backgrounds and cultural orientation, simulation software should consider interest of learners' core of navigation, graduation from simple to complex concepts and finally suitable design consideration should be calibrated in order to have effective simulations software. This should include subject specificity, ease of operation, navigational and help concerns, interests and developmental stages of learners, feedback mechanisms as well as multi – media issues.

In conclusion, the process of simulations design should involve the creation of a simulation model and learners interface, creation of an instruction design of the environment and institutional intervention as well as integration of the parts of the environment to a complete system. There is need to consider the goal, performance, target population, analyzing task, media selection and cost analysis, interface design, sequencing lessons design and learners control, collaboration between programmers graphic artist, writers and subjects matter expects, implementation subjects matter explain, implementation and evaluation goals, e.g. delivering the final products to learners and evaluating whether goals are met.

Software should provide motivation, reveal misconceptions that would inhibit learning, provide an organizing cognitive structure for receiving new material service as concrete example of complex, abstract concepts and have capabilities for scaffolding and meta- cognition. Professional developmental should be provided to help teachers understand the needs of developmental students (Boylan, 2002). Teachers must be committed to continually improving their instructional practice in order to provide a high-quality education for all students, no matter what method of instruction is being used.

Although lecture alone has not been effective with students with PD, there is evidence in the literature that enhancing the lecture with such techniques as group work, cooperative learning, class discussions, real-world examples, and peer tutoring has positive results. Educators using the traditional lecture should examine their teaching practice and find ways to enhance the lecture with active learning and relevant examples that will motivate students to learn. Courses could be redesigned with classes meeting four or five days a week. Two or three days could be lecture and the remaining days would be for students to work problems and take quizzes.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusions and recommendations of the study as per the research objectives.

5.2 Summary of Findings

5.2.1 Instructional strategies for teaching mathematics to learners with PD in Kenya

The results indicated most of students were taught through traditional method although their performances were below average. Majority of the students started interacting with computers while in form three. There was also use of techniques such as group work, cooperative learning, class discussions, real-world examples, and peer tutoring to improve results. Students reported that CBL is easier to understand than traditional method. Students agreed that computers added value to their motivation and achievement. The software was helpful to students as it made students enjoy mathematics and added value to their learning. However, the respondents suggested that the software need still be improved by introducing new methods, modifying the input method to suit the learners with varied physical disabilities and also connecting the computers to the internet.

The rapidly changing capabilities of computer hardware and software, computers have the potential to enhance learning in a greater variety of ways. When traditional instruction is supplemented with computer-assisted instruction, students receive traditional instruction in the classroom, but the computer changes how they study outside the classroom.

Professional in-service should be provided to help teachers understand the needs of the learners with physical disabilities. Teachers must be committed to continually improving their instructional practice in order to provide a high-quality education for all students. Teachers using the traditional lecture should examine their teaching practice and find ways to enhance the lecture with active learning and relevant examples that motivates students to learn.

5.2.2 Effect of Computer based use on mathematics performance

From the study the lowest students' academic achievement in Mathematics was during the pre-test in school A, B and C, with a mean score of 50.60. However the highest students' academic achievement in Mathematics was during the adoption of CBL method having a mean score of 63.75. On average the adoption of traditional method after subjecting the students to the CBL method had an average mean score of 56.40. This mean score was higher than that of the pre-test but lower than that of CBL method.

There was a statistically significant difference at the $p<.05$ level in CBL method [F (2, 125) =33.14, p=.000]. Since the effects of CBL method was found to be significant, it implies that the means differ more than would be expected by chance alone and despite reaching statistical significance, the actual difference in mean scores between the groups was quite small. There was no statistically significant difference $p>.05$ in pre-test [F (2,125) =.234, p>005] and traditional method [F (2,125) =2.29, p>005]. Since the effects of traditional method were found to be not significant, it implies that the means do not differ much.

From the test result, the pre-test and post-test were found to be significantly different p = 0.000 at 95% CI (-35.2316, -16.9112).The researcher then grouped the respondents from the treatment arm of the study into two groups; group 1 and group 2, they were then taught for a period of time using two different methods of learning and given three series of tests at the end of that period.

The tests were then administered to students in groups 1 and 2, where group1 were students who have been using CBL in learning mathematics while group2 were students who have been using traditional method in learning mathematics. Students who have been using CBL throughout the learning period posted, on average, higher results (test1 = 90%, test2 = 94% and test3 = 88%) in all the three tests compared to their counterparts who have been using traditional method.

More tests were further administered to all respondents under study through cycle 1 (comprised the students in the control group) and cycle 2 (comprised the students in the treatment group) in order to compare the speed taken in solving mathematical problems alongside measuring achievement. In cycle 1, students used the traditional method to solve mathematical problems while in cycle 2 they used the CBL method. The students who took the test in cycle 2 and used the CBL method to solve mathematical problems showed slightly higher speed in solving the problems (average time of 38.07min) compared to the traditional method where they required slightly longer time to solve the problems (average time of 40.88min).

The current study found significant difference in final exam scores of students receiving traditional instruction and those receiving CBL. The adoption of CBL methods influenced the students' Mathematics performance among the students with physical disabilities.

5.2.3 Challenges faced by the learners with PD in learning mathematics using CBL methods in Kenya

Both mathematics teachers and learners with PD encountered some challenges while using the CBL method in doing mathematics that range from inadequate computers, software to unmodified inputs of the existing computers like key boards. The solutions to these problems included adding more computers, buying more software, activating the site in discs and flash from form one in all the secondary schools of learners with physical disabilities if they are to perform well and compete at the same level with their non-disabled counterparts.

The students with physical disabilities learn extremely well with computer based use. The low performance in mathematics was associated with the traditional method of learning mathematics, while the use of CBL greatly led to improvement in mathematics performance alongside creating an enjoyable environment for learning. The same students also learn equally well in traditional lecture supplemented with computer-based learning method in mathematics.
Students have an interest in using technology for a variety of purposes including academics. They provide educators the opportunity to create courses in a variety of alternative formats to the traditional lecture methods in order to address the different learning styles and preferences of students with diverse special needs.

The use of CBL had the potential to enhance learning of mathematics among the learners with PD. When traditional instruction methods were used after computer-assisted instruction, the students demonstrated better performance than their colleagues who had not been introduced to use of computers at all. The results however were lower than the results of those who were presently on the treatment group. Notable challenges include the government unpreparedness to handle this category of learners due to lack of equipments that add value to existing computers that by and large are tailored towards the able.

The computer use in teaching and learning of Mathematics among the learners with disability is still in its early phase. Integration of computer in the teaching and learning of Mathematics suffer from inadequate computer infrastructure in schools, ill equipped and overburdened teaching force and overstretched school budgets incapable of sorting out the financial challenges that the schools face relative to computer integration in the teaching and learning process. There is need to address those factors affecting computer use in teaching and learning of Mathematics among the learners with PD in order to integrate its use in the teaching and learning of Mathematics in schools.

5.3 Recommendations

The following recommendations need to be strengthening for better achievement of learners with physical disabilities in learning mathematics using CBL;

1. There is need for adaption of CBL methods among learners with physical disabilities in schools in order to improve their performance in mathematics.
2. The CBL Methods should be used by teachers to teach students with physical disabilities in their classroom since it enhances their motivation towards learning of Mathematics.
3. There is need for provision of varied mathematics software tailored towards the learners with PD. Also training opportunities for regular classroom teachers should be conducted in order to equip the learners with computer based skills in their studies and their general lives.
4. There is need to diversify the use of CBL methods among the learners with PD in all areas of instruction apart from mathematics
5. Education stakeholders in the country should finance provision of computers, power generator, mathematics computer software, and expand computer laboratories in all

secondary schools. This will enhance the use of computers in the teaching and learning of mathematics among learners with physical disabilities.

5.4 Suggestions for Further Research

The study finds out other areas that should be considered for further research. These include:-

1. Establishing success of implementation of laptops to class one pupils of the public primary schools among the physically disabled learners in Kenya.
2. Determining the effects of computer based learning in mathematics performance among the learners with other forms of impairments in the secondary schools in Kenya.

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