UNIVERSITY OF CAPE COAST

THE EFFECTS OF COMPUTER-ASSISTED INSTRUCTION ON THE ACADEMIC ACHIEVEMENT OF SENIOR HIGH SCHOOL STUDENTS IN PLANE GEOMETRY IN THE WEST AKIM MUNICIPALITY

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Dissertation submitted to the Centre for Continuing Education of the Faculty of Education, University of Cape Coast, in partial fulfilment of the requirements for Award of Master of Education Degree in Information Technology

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2009

DECLARATION

CANDIDATE'S DECLARATION

I hereby declare that this dissertation is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere.

Candidate's Signature……………………………………Date…………………

Name: Professor Theophilus A. Ossei-Antto

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of the dissertation were supervised in accordance with the guidelines on supervision of dissertation laid down by the University of Cape Coast.

Supervisor's Signature……………………………………Date……………….

Name:…………………………………………………………………………..

ABSTRACT

The study sought to find out the effects of Computer-Assisted Instruction on the academic achievement of Senior High School (SHS) students in Plane Geometry in the West Akim Municipality. It specifically investigated whether Computer-Assisted Instruction has any effect on gender as far as the academic achievement of students is concerned.

The quasi experimental group design (or the non-equivalent group design) was employed as the research design. Students from two comparable classrooms from two distant Senior High Schools were purposefully selected as the control and experimental groups respectively for the study. The sample consisted of one hundred and seven (107) first year Agricultural Science students with 21 females and 86 males. The control group was fifty (50) while the experimental group was fifty-seven (57).

A paper and pencil test, based on the Plane Geometry 1 syllabus of the Senior High School (SHS), was used as the main instrument for the study. The instrument was pilot tested at a different Senior High School and had a reliability coefficient of 0.89. The SPSS software was used to analyze the data and test the hypotheses. The study showed that:

1. There is a significant difference between the academic achievement of SHS students who are exposed to Computer-Assisted Instruction and those who are not, in the study of Plane Geometry.

2. There is no significant difference between academic achievement of female and male SHS students exposed to Computer-Assisted Instruction and those not exposed to it in the study of Plane Geometry.

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children, Emmanuel, Pious, Doris, Barbara and Caroline, for their commitment and support.

DEDICATION

I dedicate this work to my lovely wife, Lizzy, and children, Emmanuel, Pious, Doris, Barbara and Caroline who endured my absence for the several weeks.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

Background to the Study

The unfolding recognition and importance of Information and Communication Technology (ICT) in the transformation of the economies of countries and the creation of wealth cannot be ignored by a developing country like Ghana aspiring to become a middle income country by 2015. Indeed a well thought-out and effective training programme of ICT in education should provide the panacea of skilled human resource base to meet the demands of the emerging business and industrial activities to cushion the creation of wealth that will propel Ghana into middle income status by 2015.

The Ministry of Education, Youth and Sports Report (2003), on Meeting the Challenges of Education in the twenty-first century observed that “ICT training is provided mainly by private sector in a fragmented, unregulated and uncoordinated manner” (p. 266). According to the report, it is only in recent times that attempts are being made to introduce ICT into the educational institutions as a course. In the light of the fact that ICT training was being provided in fragmented and unregulated manner, the report made a recommendation to the effect that “ICT should be introduced as practical hands-on activity at the junior high school to stimulate the interest of children and at the senior high school both as curricula activity for all students and as an elective subject” (p. 267).

Computer-Assisted Instruction (CAI) is an instruction which is presented on a computer. Such computer programmes are interactive and has the capacity to illustrate mathematical concepts through multimedia. Steinberg (1991) emphasized that CAI as computer-presented instruction is individualized, interactive and guided. In the United States of America (USA), it is generally accepted that the increasing impact of ICT on the American society is partly due to its influence on teaching and learning. According to Sandholtz, Ringstaff and Dwyer (1997), "ICT can reduce several problems in present day education, such as the need for individualized and the poor transfer of school knowledge to real life" (p. 243). The new demands of society brought about by technological advancement require that Ghana's education be focused on information management and communication skills. In this respect ICT can be a valuable tool for learning these skills.

The traditional methods of teaching have a significant limitation. Essentially, the model propounded by the behaviorists' theorists is in serious conflict with current views espoused by the constructivists. The impact of effective learning and with profiles of what today's learner needs/wants is the heart of an ICT learning environment. At the root of the traditional model lies the notion that knowledge resides in the head of the teacher, and the student acquires this knowledge by listening to the teacher. Obviously, this traditional concept is no longer feasible under an ICT learning environment which has more to do with the learner constructing his own learning. This implies that the teacher's roles and tasks would also change as Ghana Education Service (GES) embraces an ICT learning environment.

In fact, the paradigm shift from the traditional method to the constructivist approaches to teaching and learning holds students accountable to their own learning. This is because in constructivist learning environment learners construct their own learning. This is made possible again, because information technology present appropriate environments and tools that support the process of learners constructing their own learning. Knowledge of what constitutes effective teaching and learning has increased significantly in recent years. For example, knowledge of the psychology of child development and learning has become more complicated in its capacity to provide an able and informed context for instructional decision-making. In addition, knowledge of teaching and learning styles has led to an approval of what constitutes the best practice in meeting individual student needs. Educators identify, too, that learning is an interactive course of action, and that students need to be vigorously involved in tasks that are attainable, useful, relevant, and challenging if they are to respond successfully to the curriculum challenges posed for them. Under the new paradigm the learner is given control of the experience, under the guidance and direction of a skilled instructor.

The teacher's role becomes that of facilitating the process of instruction. This process empowers learners by placing them at the centre of the learning experience allowing them to personalize their learning based on needs and motivations. The direct instruction strategy is highly teacher-directed and is among the most commonly used. This strategy includes methods such as lecture, didactic questioning, explicit teaching, practice and drill and demonstrations. The direct instruction strategy is effective for providing information or developing step-by-step skills. This strategy also works well for introducing other teaching methods, or actively involving students in knowledge construction. Direct instruction is usually deductive. That is, the rule or generalization is presented and then illustrated with examples.

While this strategy may be considered among the easiest to plan and to use, it is clear that effective direct instruction is often more complex than it would first appear. Direct instruction methods are widely used by teachers, particularly in the higher grades. The predominant use of direct instruction methods needs to be evaluated, and educators need to recognize the limitation of these methods for developing the abilities, processes, and attitudes required for critical thinking, and for interpersonal or group learning. Inquiry, induction, problem solving, decision making, and discovery are terms that are sometimes used interchangeably to describe indirect instruction. In contrast to the direct instruction strategy, indirect instruction is mainly student-centred, although the two strategies can complement each other. Examples of indirect instruction methods include reflective discussion, concept formation, concept attainment, problem solving, and guided inquiry. Indirect instruction seeks a high level of student involvement in observing, investigating, drawing inferences from data, or forming hypotheses. It takes advantage of students' interest and curiosity, often encouraging them to generate alternatives or solve problems. It is flexible in that it frees students to explore diverse possibilities and reduces the fear associated with the possibility of giving incorrect answers.

Indirect instruction also fosters creativity and the development of interpersonal skills and abilities. Students often achieve a better understanding of the material and ideas under study and develop the ability to draw on these understandings. In indirect instruction, the role of the teacher shifts from lecturer/director to that of facilitator, supporter, and resource person. Indirect instruction relies heavily on the use of print, non-print, and human resources.

Learning experiences are greatly enhanced through cooperation between teachers, and between teachers and the teacher-librarians. The indirect instruction strategy can be used by teachers in almost every lesson.

In order for students to achieve optimum benefits during indirect instruction, it may be necessary for the teacher to pre-teach the skills and processes necessary to achieve the intended learning outcomes. Skills and processes include observing, encoding, recalling, classifying, comparing/contrasting, inferring, interpreting data, predicting, elaborating, summarizing, restructuring, and verifying. Indirect instruction, like other strategies, has disadvantages. Indirect instruction is more time consuming than direct instruction, teachers relinquish some control, and outcomes can be unpredictable and less safe. Indirect instruction is not the best way of providing detailed information or encouraging step-by-step skill acquisition. It is also inappropriate when content memorization and immediate recall is desired.

Apparently it becomes more important that students learn how to search, select, process and use information. The teacher's task has to guide these processes and it is this development that determines their new role as facilitators, mentors, or coaches. This approach points out a new didactical concept in which the student works more individually and independently. The teacher has to possess an appropriate knowledge base as an essential ingredient for creating powerful learning environments and an adequate provision of instructional material to support the student to construct her/his own learning.

As Schrum (1999), points out “learning about technology is a nontrivial and life changing event, and is qualitatively different from learning other new skills, knowledge and activities” (p. 85). Accordingly, anyone who has struggled to learn about technology or who has taught others to use it is aware that brief exposure does not provide sufficient training or practice to incorporate technology into a classroom. Again, traditional educational practices no longer provide the individual teachers with the necessary skills for teaching students to survive economically in today’s technologically labour market.

Consequently, it is critical that all classroom teachers are prepared to provide their students with opportunities that technology brings. Indeed being prepared to use technology and knowing how that technology can support students’ learning have become integral skills in every teacher’s professional repertoire. Teachers have no option than to empower students with the several opportunities that technology can bring.

Statement of the Problem

The use of computers to present instruction direct to students engages in activities traditionally associated with human teachers. It can present instruction, provide instructional activities, quizzes or otherwise requires interactions from learners, evaluate learners’ responses, provide feedback and determine appropriate follow-up activities. The computer, in the role as an assistant, aids both the teacher and the learner to perform routine tasks. Learners can employ the computer to produce end of term paper, assignments and for making presentations in classrooms.

The computer is indeed a multifaceted tool that both teachers and students can use in many different ways in the classroom. This in itself poses great challenge because it can either improve the lesson delivery or mar it. It can also lead to good learning strategies or bad learning strategies. The onus therefore, is how to find out the best methods of use of computers to help in the overall lesson delivery that would make introduction of computers into the educational system a healthy adventure.

In the past twenty years, computers have become an essential tool for communication, work and entertainment. For the new generation of children born in industrialized countries, a world without computers and video games seems more preposterous than a little green man from Mars. Computer-related occupations are the fastest growing segment of the modern job market, and the mastery of computer technology gives a competitive edge to individuals and nations alike. To address this growing need for a technology-savvy population, policymakers and administrators are scrambling for money to bring computers into the classroom, while critics argue that this money can be better employed on traditional instructional methods. This debate is critical, particularly for developing countries, due to the magnitude of the investment involved in buying and maintaining computer hardware and software, and providing adequate training for teachers and school staff.

In this 21st century, to live and work successfully in an increasing complex, information-rich and knowledge-based society, a student must utilize technology effectively. Within the current educational reform programme technology should enable students to become capable of both information seekers and users. Through effective use of technology in the schooling system students would be given the opportunity to acquire important technology capabilities and that the key individual in helping the student to develop those capabilities is the classroom teacher. However, in undertaking that exercise the teacher should employ a system of instruction that allows students to construct their own meaning and knowledge in whatever they do. Since, computer-assisted instruction moves at student's own pace it normally does not move ahead unless the student has mastered the skill required to move on.

Computer programmes in Mathematics demonstrate how facts and concepts are introduced, through to how the concept could be applied in solving problems. Such problem solving activities help students to improve their thinking skills thereby enhancing academic achievement. On-line tutorials and helps are becoming so influential, that "any person" will be able to learn how to use computers very fast at any age. The use of computers will be part of on-the-job training, provided by the enterprises themselves. Ghana has introduced ICT into her educational system and therefore it is important to take a critical look at this initial stage so that we do not compound the already complicated problems in our educational and socio-economic development.

Teachers have been mandated to play a crucial role in the education delivery system in the country. Their output is reflected in the performance of their students. Where students perform better at the end of their studies the teacher is deemed to have performed better and vice versa. With the introduction of computers in the classrooms, it is important to conduct a study to find out the effectiveness of computer-assisted instruction in the lesson delivery aspects of the teaching-learning process especially in mathematics classrooms in SHSs in the West Akim Municipality.

Purpose of the Study

The purpose of the study is to find out the effectiveness of computer-assisted instruction on the academic achievement of Senior High Schools students in the study of Plane Geometry in the West Akim Municipality of the Eastern Region of the Republic of Ghana. The study in particular sought to find out if significant differences existed between students who have had computer assisted instructions and those who did not have such instruction. Again, the study did investigate if computer assisted instruction had any effect on gender.

Research Questions

The following research questions were posed for the study:

1. What are the effects of computer-assisted instruction on the academic achievement of Senior High School students studying Plane Geometry in West Akim Municipality?
2. What are the effects of computer-assisted instruction on academic achievement of female and male Senior High School students studying Plane Geometry in West Akim Municipality?

Research Hypotheses

From the research questions, the following hypotheses were formulated to enable the researcher to explore the problem in depth:

1. There is no significant difference between the academic achievement of students exposed to computer-assisted instruction and those not exposed to in the study of Plane Geometry.
2. There is no significant difference between the academic achievement of the female and male students exposed to computer-

assisted instruction and those not exposed to in the study of Plane Geometry.

Significance of the Study

The findings of the study might provide significant information on computer assisted instruction which could be used by policy makers and stakeholders to make informed decisions about how to proceed with the introduction of computers in the classroom as envisaged by the new educational reforms. Again, the outcome could be of great help to non-governmental organizations in their attempts at helping some schools in setting up computer laboratories, and kinds of software to be used in integrating computers into mainstream education.

Delimitation of the Study

The study sought to find out the effects of computer-assisted instruction on the academic achievement of Senior High Schools students in Plane Geometry and those who were not exposed to such instruction. It also investigated if computer-assisted instruction had any effect on gender as far as the academic achievement of students studying Plane Geometry is concerned. The study did not focus on adequacy or not of computers in the system or lack of materials to be used for the computer-assisted instruction.

Limitation of the Study

The study is only limited to two of the three SHS schools in the West Akim Municipality in the Eastern Region of the republic of Ghana.

The small size of the female sample as opposed to the male sample is the most obvious limitation of the study the results of the groups cannot be compared generalization purposes.

The study was conducted away from the researcher's location, and the three hour continuous sessions of pretest, followed by intervention and the posttest with only ten minutes break took a toll on the students and that could have had adverse effect on their performance.

Definition of Terms

ICT – refers to Information, Communication and Technology. (It is a generic term referring to technologies which are being used for collecting, storing, editing, retrieving and passing on information in various forms).

SHS - refers to Senior High School.

PI – refers to Programme Instruction.

CAI –refers to Computer-Assisted Instruction.

SKCD –refers to Suhum Kraboa Coaltar District.

CBE – refers to Computer-Based Education

CBI- refers to Computer-Based Instruction

CAL - refers to Computer-Assisted Learning

GES – refers to Ghana Education Service

MOEYS – refers to Ministry of Education, Youth and Sports

LTM – refers to Long Term Memory

STM – refers to Short Term Memory

WAM – refers to West Akim Municipality

CHAPTER TWO

REVIEW OF THE RELATED LITERATURE

The major objective of the study was to determine the effects of computer-assisted instruction on the academic achievement of senior high school students in Plane Geometry. It reviewed the theoretical and empirical frameworks of computer-assisted instruction. The topics discussed in the chapter include the theories of learning, computer assisted instruction, the nature of computer-assisted instruction; methodologies of computer-assisted instruction (CA1) and programmed instruction and research on computer–assisted instruction.

Theories of Learning

The theories of learning discussed here are those theories relating to computer-assisted instruction, how the theories of learning and that of computer-assisted learning have impacted on the students' learning. A theory is a systematic plan for development of a pattern of ideas and concepts followed by series of procedures for implementing it out. Bigge and Shermis (2004) defines a learning theory as "a systematic integrated outlook in regard to the nature of processes whereby people relate to their environments in such a way as to enhance their ability to use both themselves and their environments in an effective way", (p. 3).

Many psychologists have concerned themselves with developing new theories of learning that would support their understanding of the learning processes which mainly centred on problems related to cognitive, construction, behavioural, motivational, perceptual, memory, coding, and transfer of learning among others. Incidentally, these theories are not translated into educational practice until after decades. Even when they come to be accepted they do not replace the existing ones. Instead they only compete with the former ones which make educational practice more complex for teachers. As noted by, Bigge and Shermis (2004, p. 5), "Many teachers have from time to time adopted conflicting features from a variety of learning theories…basically contradictory in nature and could not be harmonized with each other". Indeed psychology is not a body of theory that is internally consistent with and accepted by all psychologists. It is a body of knowledge which is characterized by the availability of several schools of thoughts. Whereas some of these thoughts supplement one another, at other times they might be in open disagreements. Hence, "one of the greatest challenges of psychological study lies in theoretical disagreements; only to the extent that students are willing to emerge from their studies with something worthwhile", Bigge and Shermis, (2004, p.5). It is like everything teachers did was based on the psychological theory that they held.

Learning Principles

Developing any effective material to facilitate learning requires an understanding of the principles underpinning how people learn. Just as engineering is the application of basic principles from physics and chemistry so is instruction the application of basic principles of learning. The design of educational courseware should be guided by the principles of learning and consistently assessing whether the courseware reflects the principles of learning that have been adopted or applied.

It must however, be pointed out that psychologists do not agree on a universal approach. Today many educators are strong proponents of different methods, whereas a few others take a more eclectic approach which comprises a combination of principles from different theories. Basically, there are three strong methods namely; behavioural, cognitive and constructive principles of learning and these to some extent have withstood the test of time.

Behavioural Principles of Learning

According to Alessi and Trollip (2001), behavioural psychology and its principles of learning began at the beginning of the twentieth century, first and foremost with the work of Edward Thorndike and later Ivan Pavlov (p. 17). Pavlov's classical conditioning research noted that an animal's basic instinctual response to natural stimuli could be associated to artificial stimuli. Pavlov would ring a bell each time he gave a food to a dog and observed that eventually the dog would salivate at the ring of a bell even when no food was available. The unconditional (or natural) stimulus of food elicits the unconditional (also natural) response of salivating. The neutral stimulus of a bell does not normally elicit salivation, but after training it becomes a conditional stimulus, and salivation in response to a conditional stimulus is a conditioned response.

Indeed the basic principle of classical conditioning is that repeatedly pairing a neutral stimulus (one that elicits a natural response) causes the neutral stimulus also to elicit the response. The implication is that humans learn much behaviour because of their pairing with basic human needs and responses, such as the need for food, sleep, reproduction and others of the same likeness.

Skinner (1971) believed that human beings are faced with problems that threaten our very existence. He argued that although we misuse the products of our technology, we can at the same time utilize the same technological prowess to solve our problems with emphasis on education. According to him "we had taken steps in solving problems like improved methods of food production, disease control, and population control but in all these, we have succeeded in just scratching the surface", (p. 1). In his view the situation is so because the solutions to these problems lack understanding of the human behaviour. Like in present day Ghana we are engulfed in filth because people are ignoring the control of sanitation procedures, which in Skinner view the processes so far lack human understanding. "Thus what we need are drastic changes in our behaviour", (p. 4). This is what the first President of the Republic of Ghana, Dr. Kwame Nkrumah referred to in his famous independence declaration speech as what we need to do to move the country forward as Ghanaians capable of managing our own affairs is to change our attitude.

To Skinner, we have not made progress in understanding human behaviour because we refuse to give up "mentalistic" explanations of behaviour that allude to helping us understand our actions but in fact hinder us in our quest for understanding behaviour. The problems seem to be solved and we are lured into a false sense of security. Accordingly, Skinner maintained that "scientific approach to the study of human behaviour must give up such nebulous explanations and search for the precise antecedent events that actually produce behaviour", (Skinner, 1968, p. 785). Skinner opted for a detailed examination of the environmental determinants of behaviour. In his opinion, education involves "the arrangements of contingencies of reinforcement under which students learn", (Skinner, 1968, p. 64). According to him these contingencies could be effectively arranged through the use of teaching machines, computer-assisted instruction and other programmed techniques. Complex subject matter is presented to the student in a series of small easy-to-learn steps. In one form of programme learning a question is posed and the students write their answer in a space provided by the programme. Then they lift a lever that moves the answer under a transparent cover and simultaneously exposes the correct answer. If their response matches with the answer, the student punches a hole in the paper to signify that they have answered correctly. This procedure instructs the machine to allow the next question to appear. This procedure is followed to answer all questions and it is repeated until they answer all questions correctly, thus achieving mastery of the programme materials, (Skinner, 1968). The teaching machine advocated by Skinner is programmed to ensure that the student thoroughly understands a point before he or she can proceed.

One of the basic tragedies of traditional educational practices is that, all too often, the teacher is faced with the task of educating large numbers of students simultaneously. Under such conditions, it is impractical for even the best teacher to give the same amount of individual attention to each student. Incidentally, the greatest merit of computer-assisted instruction is that computer reinforces the student sufficiently for each response and does it immediately.

In fact, the teacher in the traditional setting knows the value of immediate and adequate reinforcement not forgetting individual attention but is technically handicapped in terms of time and additional resources to provide it. Programmed learning approach on the other hand recognizes the importance of individual differences and immediate and adequate reinforcement is catered for in the feedback provided. Skinner (1968), maintained that “failure to account for these differences is the greatest single inefficiency in education today” (p. 242).

Although, he was hopeful of his programmed-learning approach and eventual change in the educational system, he equally realized the enormous resistance by educators of his time. Skinner (1968) found that

Many of those educators charged with the improvement of education are unaware that . . . technical help is available and many are afraid of it when it is pointed out. “They resist any new practice which does not have the familiar and reassuring character of the normal day-to-day communication and they continue to discuss learning and teaching in the language of the layman” (1968, p. 259).

Cognitive Principles of Learning

Cognitive psychology takes its name from the word cognition, which is interpreted simply as the process of knowing. This distinguishes it from the behavioural principles and thereby places a lot of emphasis on unobservable constructs like the mind, attitudes, memory, motivation, thinking, reflection and other constructs of similar internal characteristics. The most dominant school of thought is concerned with information-processing approach. The proponents of this school maintain that information is initially stored in the

Short Term Memory (STM), and later used or organized to be stored in the Long Term Memory (LTM). Indeed computer science also describes how information enters through our senses.

Another theory of cognitive psychology of learning is referred to as semantic networks. Semantic network theory says that our knowledge consists of nodes connected in countless ways. Several cognitive processes including thinking, acting, remembering, and problem solving activities consist of information nodes that are activated through relationships to other information links that in turn activate other information. Thus underlying the semantic network theory is “the assumption that prior learning/knowledge is crucial and therefore, learning is the incorporation of new knowledge into the network of prior knowledge”, (Alessi & Trollip, 2001, p. 20). Accordingly, incorporation may occur through assimilation or accommodation. It is assimilation if new information is modified to fit into that of the existing knowledge and accommodation if existing knowledge is modified to accept new knowledge or a little of both.

Constructive Principles of Learning:

The constructive learning psychology is now challenging the supposed dominant cognitive psychology in the face of the introduction of computers in education. The objectivists’ view or philosophy holds that “there is also an objective world that we perceive more or less accurately through our senses, and that learning is the process of correctly interpreting our senses and responding correctly to objects in our objective real world” (Alessi & Trollip, 2001, p. 31). The assumption here is that instruction or teaching is the process of helping the learner correctly interpret and operate within the real world.

Constructivism contrast this view and holds that the only reality is our individual interpretation of what we perceive.

Constructivist learning theory therefore, asserts that knowledge is not received from outside, but that we construct knowledge in the head. One of the several schools of thought is social constructivism which maintains that learning is inherently social. It holds that learning is a function of social norms and interpretations and that knowledge is not simply constructed by the individual but by social groups as well. Radical constructivism maintains that one can never really know the exact nature of the real world, so it is only the interpretation that matters. It therefore, means that learning is the process of people actively constructing knowledge. The traditional instructional methods embedded in behaviourism and cognitivism such as memorizing, demonstrating and imitating are considered incompatible with the notion that it is a process of construction.

Papert's research with his famous Logo programming language was one of the early examples of applying a constructivist view of the educational use of computers. He claimed that learners would better learn mathematical concepts and problem solving than more traditional and direct methods of teaching Mathematics and problem solving. Quite recent years "Papert and his colleagues have expanded this approach in the more general notion that people learn most things better through construction of computer programs, computer games, or multimedia compositions than through traditional methods of directly teaching content" (Harel & Papert, cited in Alessi and Trollip, 2001, p. 32).

Indeed the constructivist approach puts its emphasis on the active process of learning. It does not emphasize teaching activities and instructional methods. As a result learner activity is stressed more while presentation of information is downplayed. It also emphasizes the learner exploring, experimenting, asking questions and seeking answers. The process of construction entails learners setting a goal, making plans, doing research, creating materials, evaluating them and revising. The approach also stresses on cooperative and collaborative learning where cooperative is explained as learners helping each other rather than competing one another, while collaborative learning is the situation where learners work on shared project or goal such as a group of students working on a project.

A goal of this section on learning principles has been to summarize the different principles of learning theories and trying to understand the concepts underlying each method and how they can facilitate the design of Computer-Assisted Instruction.

Computer –Assisted Instruction

Computers are already in use in Ghana in most establishments and institutions like the banks, large firms, transport companies, the armed forces and some of the universities. Either owing to ineptitude on the part of political decision making priorities, it did not appear that the Ministry of Education was ever involved in computer-usage in lower levels of education until recently. With the growing need for computers in classroom instruction, computer training for teachers and teacher-educators is being considered as a prime objective for the advancement of educational technology. The opportune time is now to take a holistic view about the nature and effectiveness of Computer-Assisted Instruction.

The use of computers in schools may conveniently be divided into two broad categories namely: learning about computers, and learning with or through computers. Knowledge of computers may be thought of as a continuum, ranging from skills and awareness of computers as learning tools at one end through programming in higher and lower levels language, and to solid-state physics at the other end of the continuum.

The design of educational software has been a complex issue and it would continue to be so. The difficulties one has to go through before the design and development of educational software/programme is a herculean task and time consuming, and therefore, creating a variety of them is even more difficult. Whereas some are difficult others are relatively straightforward for example, Drills and Practice and Tutorials. Computer-Assisted Instruction software/programme uses a combination of text, graphics, sound and video in the learning process.

The computer has many purposes in the classroom, and it can be utilized to help a student in all areas of the curriculum. Computer-Assisted Instruction (CAI) refers to the use of the computer as a tool to facilitate and improve instruction. Computer-Assisted Instruction programmes use tutorials, drill and practice, simulation, and problem solving approaches to present topics, and they test the student’s understanding. These programmes enable students to progress at their own pace, encouraging and helping them in learning the material. The subject matter taught through CAI can range from basic mathematical facts to more complex concepts in mathematics, history, science, social studies and language arts.

Many educational software programmes follow the same design as programmed instruction. Students receive some instructional material, followed by a ‘probe’ (a small test), if they respond correctly, they move on to next lesson; if they do not, they repeat the lesson or receive a different lesson covering the same materials. This approach is called Computer Assisted Instruction (CAI).

Computer Assisted Instruction (CAI) is “relatively new field” in which the pioneer efforts occurred around 1960 following the introduction of computers into higher education. A number of large-scale, heavily funded CAI projects have been conducted since then, with their results having implications for the future use of CAI as a classroom tool.

Models of Computer Assisted Instruction

There are two models for designing interactive educational programmes. The first, Instructional System Design (ISD), the traditional model, determines a goal, sets objectives, delivers instruction, formulates test questions, and evaluates learning. The second is the Hypermedia Design (HMD), which focuses on the student’s goal and how the student chooses to access information. While ISD is concerned with design goals, HDM focuses on the user’s programme goals. Different instructional methodologies are appropriate to different goals, such as initial learning (for which tutorials are often used), retention (for which drills are often used), and transfer (for which simulations are often used). According to Alessi & Trollip, “multiple instructional methodologies need not be in separate programmes" (2001, p. 79).

There are many design models for CAI available today. One model, developed by (Gagne`, 1985) has nine phases: These phases are sequentially arranged from gain attention through informing learners about objectives, recall of prior learning, presentation of material to be learned, allow students to practice after which assessment is carried out which invariably aids in retention and transfer of knowledge.

After each phase is completed, it must be evaluated before moving to the next phase. CAI design projects should consist of several members including a project manager, subject experts, advisors, evaluators, programmers, and graphic artists. The CAI must meet the needs of its users to be effective. Also, computer literacy can be a major problem. Students without basic computer skills may not be comfortable using the courseware. This means that students will have to master basic computer knowledge before using the CAI successfully. This again leads to the issue of learner control of a program. Learner control is more beneficial when learners receive specific feedback regarding their progress and the success of their decisions. The constructive approaches emphasize on providing greater learner control and this has lent itself to more controversy on the subject. The best approach is "to provide intelligently some learner control for appropriate aspects of a programme depending on the methodology, the educational level of the learner, the programme complexity and the overall educational philosophy" Psotka, Kerst, Westerman, & Davison, cited in (Alessi & Trollip, 2001, p.52).

Types of Computer-Assisted Instruction

Computer-Assisted Instruction (CAI) is defined as the use of computer to provide course content instruction in the form of drill and practice, tutorials, and simulations. Drill and practice is a common Computer-Assisted Instruction form in which a type of repetitive, or “flash card” approach is used to emphasize the retention of information. It is used extensively at some of the lower levels of education.

Tutorials use the computer in a higher-level mode in which question-and-answer or dialogue type of learning in the traditional tutor mode is emphasized. It is used extensively at some educational levels.

Simulations, a third type of Computer-Assisted Instruction, provide a model in which the student plays a role and interacts with the computer. Simulations have been used most often in higher education to model scientific processes. They are applicable to any field, however, and can be of significant help in illustrating concepts, in helping students to develop problem solving techniques, or in allowing students to explore complex interactions. These three categories; tutorials, drill and practice, and simulations make up what has become known generally as Computer-Assisted Instruction (CAI), computer-based instruction (CBI), or computer-based education (CBE). In Europe and elsewhere, these activities are usually referred to as computer-assisted learning (CAL).

Characteristics of Computer-Assisted Instruction

A computer is programmed with linear or branching programmes. It acts like a super teaching machine catering for the needs of a number of students at the same time. The characteristic aspect of the CAI is its capacity to initiate flexible interactions with the students that is not possible in the teaching machine. There are a number of ways in which this can be done. The computer is able to record and store all the responses of students working with that software. It can use the information in deciding what information to give the student next. It can branch not just in terms of one answer but also in terms of a whole series of previous answers. It can also record the time taken to answer a question and the degree of correctness of the student's response. It uses the information in planning to determine which branch to take (Sampath & Quaine, 1990).

A typical CAI installation consists of individual learning booths, each with a console. The student is seated. Facing him on the console is a television screen for displaying information. Before the student starts a programme, he checks in with the computer by displaying his identity number. This connects him with his part of the learning programme. Slides, motion picture films, filmstrips, etc. the student may question the computer and feed answers into it by means of a typewriter keyboard. The computer responds by printing our comments, answers and questions. Sometimes, the student may write directly on the cathode ray tube display screen with a 'light pen'. His answer will be picked by the computer and evaluated.

CAI starts by identifying the way a student seems to learn best. It reviews his past history of learning and then presents a programme built on his strength. Sometimes the computer stores all the information gained from all students who have taken the computer course previously. Computer-Assisted Instruction is, therefore, not merely a sophisticated type of programmed instruction but it also uses electronic data processing, data communication, concepts of audio-visual and media theory, communication theory, system theory and learning theory. In contrast to CAI, Computer-Managed Instruction (CMI) analyses the relationship between various factors pertaining to a student and suggest activities appropriate to the individual student.

Computer-assisted instruction makes use of multimedia software in the learning process including text, video technology, graphics, sound and Internet technology. Computer-assisted instruction is heavily used in the growing field of distance education. Traditionally, computer-assisted instruction, like programmed instruction, has been linear in nature.

There are numerous unique features of CAI which make it an exciting field. One of the most useful is its adaptability in distance learning. Before the dominance of microcomputers, distance learning was mostly accomplished through programmed instruction or mail system supplemented by telephone contact. On the contrary, CAI provides regular and timeous interaction with the instructors and current feedback. Students can repeat tutorials as often as needed and work at their own pace. CAI also can be used with greater numbers of students than a traditional classroom would hold.

CAI and web-based instruction have opened avenues of access to individuals with disabilities that were not previously possible. Intelligent Computer-Assisted Instruction (ICAI) is programmed so that the CAI adapts to a student's individual needs. It acquires information about the student's current knowledge of a subject and his/her goals in learning the subject and then creates a user profile based on this knowledge. It can then adjust itself to the individual student. Web-based instruction can be a valuable component of a multimedia course or a course can be delivered on the Web alone. It is an increasingly common practice in some traditional teaching institutions to require the faculty to take on a small number of students at a distance (Moore & Kearsley, 2005). Indeed with Web-based instruction, students and/or instructor can communicate with each other anywhere in the world within seconds via the internet. Feedback from the instructor can be obtained immediately.

Drills and Practice

Computer-assisted instruction facilitates students learning through various methods. Different types of CAI tutorials, simulation, drills and practice, problems solving and games are discussed in the following pages. Although a computer can be used in many ways in several educational programmes, the following are some of the areas where it proves to be effective in the instructional process.

Computer-based drills are of much greater effectiveness than ordinary workbooks, flashcards and teacher-administered drills. According to Alessi and Trollip (2001), drills are not intended to teach in the sense of providing new information. Drills should be preceded by instructional methodologies that present new information and guide the learner through initial acquisition of the information. In an interactive multimedia setting this requires preceding the drill with an appropriate tutorial or simulation. It could also be preceded by readings in a text-book, a classroom lesson or a group discussion.

The general structure of a drill is that a student sits at a computer, which is connected to the internet by telephone lines. He identifies himself by a code number and his name. The machine types out the first question and the student responds. Soon the lesson is underway. The computer keeps track of each student's performance and can 'read back' to the teacher a summation of each student's work whenever the teacher wants it. Depending upon the programme, the student might be referred to a branching type of remedial exercise. Like in programmed instruction, the student moves at his own pace, gets immediate feedback and receives individual tutoring. Drills and practice software differs from tutorial software in a key way: It helps students remember and utilize skills they have previously been taught, whereas a tutorial teaches new material. Students must be familiar with certain concepts prior to working with drill and practice programme design that includes the following four steps:

1. The computer screen presents the student with an item to respond to or problems to solve;
2. The student selects an item or responds to the question;
3. The computer judges the student's response with a feedback;
4. The student receives the feedback about the response.

After a number of trials the programme terminates and this procedure differs from that of the tutorial Alessi & Trollip, (2001).

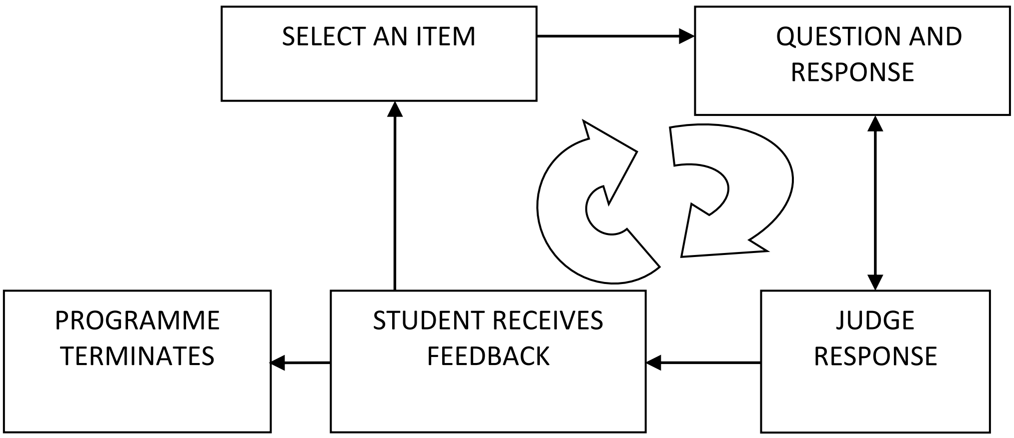

Figure 1: The General Structure and Flow of a Drill

Tutorials

With tutorials, the subject-matter is literally taught by the computer programme. Explanations are given orally through audio-tape and needed visuals presented in cathode ray tube as in television. The student responds on a computer with a click on the keyboard or by pointing on the screen with a light pen. The computer reacts to the student's response by 'talking' to him. Student makes further response. A kind of dialogue takes places between student and computer. CAI tutorials are based on the principles of programmed learning.

The student responds to each bit of information presented by answering questions about the material and then gets immediate feedback on each response. Each tutorial lesson has a series of framed questions. Each frame poses a question to the student. If the student answers correctly, the next frame appears on screen. There is disagreement among educators on how these frames should be arranged. Some educators are proponents of the linear tutorials, whiles others prefer the branching tutorials.

The linear tutorial presents the student with a series of frames, each of which supplies new information or reinforces the information learned in previous frames. The student has to respond to every frame in the exact order presented, and there is no deviation from this presentation, but the student does have the freedom to work through the material at his/her own speed. The branching tutorial allows more flexibility in the way the material is covered.

The most common function of a response or feedback is to inform the learner about the correctness or otherwise of a response. "Providing reinforcement for the learner should follow the correct response while providing correction with the view of improving future performance should follow incorrect response. In tutorial programmes especially, feedback should encourage the learner to improve thinking and comprehension" Schimmel, cited in (Alessi & Trollip, 2001, p. 114).

While it is easy to say that tutorial programmes should be highly graphic, branched, and interactive, it is not an easy task to produce such software. The process of creating branches and alternative instructional sets for students of varying ability levels is extremely time consuming. Student misconceptions and difficulties must be predicated and appropriate instruction developed to assist the student.

Simulations and Games

Simulations have become effective in education and have been an interesting method for learning in the last decade. It is a better use of computer technology used for learning in the real world. Simulation are condensed learning exercise specifically designed to represent vital real life activities by providing learners with the essence of essential elements of the real situation without its hazards, cost or time constraints. Simulations are realistic imitations and according to Duchastel (1994) "the more accurate the representation, the better the simulation", (p. 226). Using simplified models, learners may solve problems, learn procedures and come to understand the characteristics of phenomena and how to control them, or what actions to take in subsequent situations. With simulations knowledge is integrated with reality and with behaviour. It helps students to perceive values and ideas not as the material for armchair rhetoric.

Simulations are frequently planned in the form of competitive games to increase motivation and interest. Organized social simulation is called gaming, as for example, historical games. Educational simulation and games like all other well-organized learning experiences must be carefully designed with clearly specified objectives. The most obvious use of simulation is in extending the experience of learners and in stimulating and sustaining their interests.

Simulation and games increase self-motivation and self-confidence and can accommodate students with different age's and levels of maturity. They approximate reality far more closely than conventional class methods. In simulation programmes, students take risks as if they were confronted with real life situations without having to suffer the consequences of failure. Students can experiment with dangerous chemicals on the computer screen, for example, and not be in danger from the actual chemicals. With laboratory simulations, there is no expensive laboratory equipment to buy and students do not have to wait a long period of time for the effects of experimental conditions before they can observe the results. Moreover, students can repeat experiments easily as often as they wish. Simulations save time and money, reduce risks, and work well in decision-making situations. Simulations are more difficult to design and develop than other methodologies like drills and practice and tutorials (Alessi & Trollip, 2001).

The strength of a simulation is to force students to retrieve or discover relevant knowledge, experiences and problem-solving skills under authentic situation. Exploratory simulations require students to take more responsibility in learning processes. Active learners are most likely to benefit from this kind of use of computer-based simulation. In education, simulations have become increasingly popular, especially in science, mathematics, and the social sciences. Simulations give students the chance to experience situations not normally available in classroom setting.

Animation

Animation means, literally, to breathe life into something. A transformation is involved to move things. It plays significant role in stimulating learning. In the English language animation is mostly associated with the work of film makers. Action is created from a series of images which makes us have the illusion of something that is living.

Role of the Teacher in CAI

Computer-assisted instruction is not to exclude the teacher from the classroom. Computers in the classroom mean relief from the more mechanical aspects of the teacher's work. Teachers need no longer be 'talking books' or 'paper correcting automations'. They can hereafter work in areas like evaluation, planning, curriculum revision, guidance and human relations.

CAI and Programmed Instruction

The popularity of Programmed Instruction (PI) reached its zenith in the 1960's but declined steadily through the 1970's. This decline in popularity is attributable to a variety of recognizable and somewhat vague reasons. Three primary reasons were the nature of the material and processes, the higher publishing costs, and the attitudes of teachers. Programmed materials were perceived as boring often because of the way in which they were used. Also, their success was largely predicated on users' adequate reading ability, which notably declined during the same period. On the economic side, programmed materials were more expensive to produce because of their non-standard typography. Because of lower sales, the development cost could not be spread out, forcing up the unit cost of programmes, which further depressed their sales.

Concurrent to PI's decline, the newest bandwagon in education, computer-assisted instruction, was gathering steam. This technological focus only accelerated the apparent demise of programmed instruction. Yet PI never really disappeared. Rather, it was transformed into new issues and technologies that dominated attention in the 1970's and 1980's.

Programmed instruction represents a model of how instruction should occur. Nowhere is this model more consistently applied than in computer-assisted instruction (CAI). Even though programmed instruction (PI) and computer-assisted instruction were developing independently in the 1960's, the instructional sequences and techniques of the former were borrowed by the latter. While PI (in its traditionally identifiable form) has declined in popularity, CAI is in big demand. Its continued development was fueled by the explosion of microcomputers in the 1980's and 1990's. The visual and auditory establishments afforded by the graphics and sound capabilities of microcomputers make the reinforcement of drill and practice programmes initially more desirable, and the programmes are able to keep records on a user's performance, but the fundamental instructional model is that of Programme Instruction.

Another popular form of microcomputer courseware is the tutorial mode, which replicates on the screen branching programmed instruction. The computer's programme presents some information followed by questions on the screen, and, based upon the response, branches the user to alternative parts of the programme. These programmes, like intrinsic Programme Instruction, may confirm the correct response, remediate an incorrect one, or move the user forward or backward in the programme stream. Also, a number of authoring systems are available to help computer courseware authors circumvent the need for computer-language proficiency.

Tutorials can be used for learning new educational content. The programmes differ greatly in their complexity. However, drill and practice programmes are usually quite simple while tutorials can be very complex (Watson, 1994). As stated above, the roots of computer-assisted instruction can be traced back to programmed instruction. The key concepts of programmed instruction (tutorials, management, general enrichment, drill and practice, programming and simulation programs) are present as well in CAI. When computers were first commercially presented in the 1950's, programmers had to work around the slow speed and small memory of the computer, which limited applications. As development in technology grew, the next phase of computer software which came in the 1980's made computer applications easier to use for the consumer than previously. According to Moore and Kearsley (2005), Glenn Jonas established the first Virtual University in 1993 offering bachelors and masters degrees totally over the Internet and was accredited by the North Central Association of Colleges and Schools. Today many colleges and universities offer courses and degrees via the Internet. In the 1990's , with computer speed and power much greater than ever before, the computer's role as a 'trainer' has been greatly expanded.

Merits of Computer-Assisted Instruction

Merits of Programmed Instruction are also merits of Computer-Assisted Instruction and web-based learning. The advantages of computer-assisted instruction include flexibility for students so that they can work at their own speed at the time that is best for them. With web-based instruction, they can work at home, at school, or anywhere there is computer with an internet connection. Used with distance learning, it allows students with handicaps or learning disabilities the opportunity to learn in a less restricted environment.

Computer-assisted instruction proves better than all other aids in several respects. There is not only saving of time in learning but it also performs miracles in processing the performance data. This latter characteristic helps to determine subsequent activities in the learning situations. The large amount of information stored in the computer is made available to the learner more rapidly than any other medium. The dynamic interaction between the student and the instructional programme is not possible to be secured in any other form.

Before computer can be of any use, it must be carefully programmed to perform desired functions. This requires thorough planning of every step and prior thinking. Computers are simple-minded. They demand instructions spelled out in explicit detail. Human beings are brilliant but rather sloppy thinkers; computers are stupid but are accurate.

The field of CAI is based on a number of disciplines, but its primary origins lie in computer science and psychology. From computer science and its predecessors, mathematics and engineering, came the computers and the programmes that enable them to function. From psychology came the knowledge of learning theory, instructional strategies and motivation. Complex applications of these concepts were not always applied in the design of CAI modules in the early experiment due to the major problems encountered as a result of the newness of computing hard ware, its costliness, and the difficulties in writing the programmes. Thus the early experiments in CAI were confined to fairly simple uses, such as drill and practice and tutorials.

Computer-assisted instruction satisfied many of the theoretical requirements for a "good" learning environment advanced by the leading psychological theorist such as Skinner (1968). It also permits the learner to proceed at his own pace. Finally, reinforcement of learning in such situations is immediate and systematized, which again should result in more effective learning according to established theories of instruction.

Demerits of Computer –Assisted Instruction

Demerits include the need to own or have access to a computer with the necessary RAM and operating system; lack of computer skills of many students, physical problems such as carpel-tunnel syndrome and eye disorders. Computer-Assisted Instruction must bridge different styles to be fully effective; therefore, it should offer different types of examples and ways to solve problems.

Although computers open the possibility of educating the students completely by individualized programmes, its chief limitation lies in the fact that it is expensive. Computers may also inject a non-human quality into educational programmes.

CAI and Learning Theories

There are many definitions of learning, derived from the differing explanations supplied by psychologists to account for it. For the purpose of this study, however learning is defined as the process through which experience produces changes in the nervous system, resulting in changes in behaviour. Learning is a complex phenomenon. There are many different types of learning, ranging from the simple response to the type of thought that results in the solution to a complex scientific problem. Thus, some theories of learning have been of most help in understanding that type of learning situation. As might be expected, such theories have fallen short when higher-level types of learning have been under consideration.

Conversely, other theories have been concerned with global approaches that have aided understanding of higher mental processes involved in complex learning. But interestingly, these theories have been of no significant help in accounting for the detailed components and antecedents of such behaviour. Since CAI is applicable to a broad range of learning tasks, only the major theoretical representatives of both ends of learning continuum are being considered.

It was not until the past few years that educational psychologists again began to be disturbed by the lack of progress in understanding what many believed to be fundamental problems in the field, i.e. cognitive events such as thinking, memory, perception, and mental process in general. At about this time, computers became prevalent in higher education.

The emphasis on information process (in which computers were considered to be analogous to the brain and in which concepts such as memory replaced stimulus-response bonds) was accompanied by a general social and professional acceptance of the value of such machines. This provided the ground work for revolution in that field. The revolt occurred with educational psychologist combining with linguistics and computer science professionals to form the new field of cognitive science. This field relied on understanding of the mental processes and making extensive use of modeling capabilities of computers, brought on entirely new light to bear on the subject of learning.

Most theories agreed that certain conditions are necessary in order for learning to occur. These conditions include contiguity, reinforcement, and repetition (practice). The basis for behaviourist theory was that a stimulus (S) that elicited a response (R) that was immediately followed by positive reinforcement would result in increasing the probability that the response would occur upon further presentation of stimulus. Thus, the Stimulus-Response reinforcement became the learning model. Skinner (1968), agreed with the contiguity principle and emphasized the importance of the immediacy of the reinforcement following the response (p. 39). The cognitive theorists have, in general, agreed with Skinner on this point.

There is also general agreement among the proponents of the various theories that repeated occurrences of the response followed by reinforcement are necessary in order for learning to occur and for the materials to be retained.

Cognitive Theory and CAI

Cognitive theories are based on information-processing models. These are concerned with how individuals gain knowledge and how they use it to guide decisions and perform effective actions. These theories try to understand the mind and how it works. To achieve this, they view the computer as a model of the brain and employ much of the terminology and concepts of information processing.

A cognitive learning theory is concerned with several key items: (1.) Effect of stimuli on the organism's receptors; (2) storage of information in short-term memory (working memory); (3) storage of information in long term-memory; (4) processes involved in decoding of information; and (5) retrieval of the stored information, its possible combination with other data, and its ultimate effect on behaviour of the organism. Certain stimuli in the environment affect an organism's receptors.

These stimuli produce patterns of neural activity that are briefly registered by sensory registers. The data are then transformed and decoded in short-term memory (STM), an important concept in cognitive theory. Characters of STM are as follows: (1) Only prominent features of the original stimuli are recorded; and (2) STM has the capacity to hold only about 4-7 items for a limited time (20-30 seconds). The materials then are either retained in STM through rehearsal, transferred to long-term memory (LTM), or lost.

According to one prominent model (Bower and Hilgard, 1981), LTM contains information originally held in STM, which had undergone a process of semantic encoding. This process changes information from words and stimuli to propositions that have meaning and contains codes for retrieval at later times.

Cognitive theory recognizes the importance of reinforcement, but does not give it the central importance emphasized by Skinner. The reinforcement principle indicates that learner behaviour sets in motion a process that depends on external feedback, which involves confirmation of correct performance.

An important concept contained in some cognitive theories is the executive control process. This process controls cognitive strategies relevant to learning and remembering in relation to such important activities as controlling attention, encoding of incoming information and retrieval of stored data. These types of activity were not considered in traditional behaviourism, nor were they given prominence by Skinner. Their applications to computer-assisted instruction, however, are critical. It is perhaps in this area that cognitive theory has contributed the most to CAI.

Considering cognitive learning theory overall, the following kinds of processing during single learning act could include:

1. Attention-selection among incoming stimuli.
2. Selective perception-encoding selected items for storage in long-term memory.
3. Rehearsal-maintaining data in short- tem memory
4. Semantic encoding-preparing information in working memory.
5. Retrieval-searching and resorting information in the working memory
6. Response organization-selecting and organizing performance
7. Feedback- the external event that sets in motion the process of reinforcement.
8. Executive control process-selecting and activating cognitive strategies (Bower & Hilgard, 1981).

Application of CAI

The most significant contribution of Gagne has to do with his application of cognitive learning theory to the task of designing CAI modules. He has brought to the topic some additional insight and emphasis, such as his concern with gaining the student's attention and developing expectancies. This can be achieved in a CAI module by providing advance organizers in the instruction. These organizers might take the form of charts or graphs that reflect the structure and organization of the lesson content.

He also postulated another point in his defence of drill and practice by indicating that drill and practice, if viewed as part of cognitive learning theory, simply speeds up the learning process. Thus it makes learning more efficient by making lower-level skills (such as the basic mathematics) automatic (Gagne, 1985). Since such skills are used quite often, and since short-term (working) memory has a limited capacity, drill and practice reinforce the indexing characteristics of the basic skills, thus permitting them to be retrieved and place in short-term memory for use very quickly (Gagne, 1985).

Gagne (1985) identified five categories of learning outcomes that he believed represent all types of learning. These included: (1) intellectual skills (how to do something of an intellectual sort); (2) cognitive strategies (capabilities that govern the individual's own learning, remembering and thinking behaviour); (3) verbal information; (4) motor skills; and (5) attitudes.

Within these various types of learning, Gagne (1985) expressed his belief that there must be nine events of instruction. The internal learning process (expressed in terms of cognitive theory) and external instruction events that he postulated are listed in Table 1:

Table 1: Gagne's Nine Events of Learning

Internal learning processes	External instructional events
1. Alertness	1. Gaining attention
2. Expectancy	2. Informing learner of lesson objective
3. Retrieval to working memory	3. Simulating recall of prior learning
4. Selective perception	4. Presenting stimuli with distinctive features
5. Semantic encoding	5. Guiding learning
6. Retrieval and responding	6. Eliciting performance
7. Reinforcement	7. Providing informative feedback
8. Cueing retrieval	8. Assessing performance
9. Generalizing	9. Enhancing retention and learning transfer

Bandura's Social Learning Theory and CAI

Behaviour theory in general and Skinner's operant conditioning principles in particular, have placed great emphasis on learning by direct experience, by the application of reinforcement to response. Although social learning accept these concepts as valid conditions for some types of learning, the theory also has proposed that a large amount of human learning is done vicariously, through observing another person making the responses (or reading about it or viewing picture of it) and then by trying to imitate the response of the model.

Bandura (1977), stated his views in regard to observational learning as, "Most human behaviour is learned observationally through modeling: from observing others, one forms an idea of how new behaviours are preformed, and on later occasions this coded information serve as guide for action" (p. 192).

He pointed out that observational learning is governed by four component processes: (1) attention; (2) retention process; (3) conversion of symbolic representation into appropriate action; and (4) motivational processes.

Attention refers to the fact that people must attend to and accurately the significant features of modeled behaviour. Attentional processes determine what is selectively observed and extracted from exposure to others. Retentional processes draw attention to the fact that individuals must remember the modeled behaviour in order to be influenced by it. Observers who translate observe behaviour into words pictures learn and retain better than those who do not. The third component of observation learning concerns turning learning into actions. This involves refinement of behaviour through self-correction adjustment on the basis of feedback. Finally, motivation affects observational learning in that behaviours that seem effective for others are favoured over behaviours that are seen to have negative effects. As a result, (Bandura, 1977) found that “high-status models are more often imitated (their behaviour is seen as leading to success) than low-status models” (p.193).

Since earlier theories were primarily concerned with reinforcement, it may be helpful to emphasize Bandura’s position: According to social learning view, observational learning occurs through symbolic processes during exposure to modeled activities before any responses have been performed and does not necessarily require extrinsic reinforcement. Reinforcement does play a role in observational learning, but mainly as an antecedent rather than a consequent influence. Anticipation of reinforcement is one of several factors that can influence what is observed and what goes unnoticed (Bandura, 1977).

Application of Bandura's Theory in CAI

The application of social learning theory is seen most appropriate for the type of learning that occurs in many CAI simulations. Although real models are not used in such simulations, the computer provides a reality situation in which the student may learn vicariously through interaction with the model. In such cases, the reinforcement apparently occurs as a result of student responses to the model, which bring about a change in the condition. The student controls the situation and is thus positively reinforced.

Several observations seem appropriate by applying social learning theory to the design of simulations. The first relates to the importance of instructions to guide student learning. The instruction should provide student with information concerning content, structure and goals of the simulation, and in addition should inform students with respect to the benefits of adopting the modeled behaviour. As Bandura (1977, p. 196) pointed out, "this will result in the development of expectations that serve to reinforce learning". Second, simulation should include as much interaction between students and the computer as possible, and the simulation should be used by each student a number of times. This will enhance retention and permit feedback to improve the modeling.

With regard to motivation the computer should serve as a model; that is as humanlike as possible while characteristics of high-status models could be employed whenever possible. The relevance of the subject matter is very vital. The degree to which students feel the subject matter is irrelevant will proportionately affect their performance. In designing CAI modules, they can be overcome by selecting topics or design themes that represent important issues for the student or by demonstrating the practical or applied aspects of the subject matter.

To sum up, reinforcement is by far the most-accepted concept in learning theories in general, and is essential to the theories outlined for use in the development of CAI courseware. Yet most behavioral theories speak almost exclusively of the need for contiguity and repetition of reinforcement. Indeed in designing CAI, both quantity and type of reinforcement are to be adopted as crucial components.

Notwithstanding this development and as far as quantity is concerned, it has not been found to be of significant importance in most studies. Thus, providing two minutes of game playing as a reward for attaining mastery, will probably achieve a significant reinforcement effects as five-minute reinforcement would provide. A key item, however, is the type of reinforcement that must be geared to the learners' needs and perceived by learners as satisfying. Relevance is the key factor, which of course makes it fundamentally difficult to design courseware applicable to diverse age and grade levels of learners.

Theoretical Framework

This research is done within the broad spectrum of constructivism traced to the works of Piaget, Vygotsky and Bandura. This new concept of learning presently dominates research in computer software/program development. Constructivism may be explained as an epistemological view which sees the learner as active participant in the teaching and learning process. The construction of new knowledge occurs at an existing context, such as culture, religion, social, economic or a geographical location.

In this context the study is seen to be organized on the principle of individuals constructing their own meaning of new information or knowledge presented to them on the basis of their prior knowledge as determined by the learning environment. The new experiences are used by the individual to construct new meaning out of what is provided. According to Vygotsky (1986), this knowledge construction is shaped through social interactions with members of the community.

It must be noted that adding a computer to the classroom is not a panacea for the challenges of teaching and learning. However, it does in very special circumstances lend itself to accommodating different learning styles which enhance and improve learning.

Research in Computer-Assisted Instruction

In a study which examined the effects of computer-assisted instruction (CAI) on the reading skills of first graders during the course of a complete academic year it was apparent that CAI is able to influence the development of reading skills, (Erdner, Guy, & Bush, 1998). The students received sixty minutes per week of CAI on a PLATO/WICAT System 300, a minicomputer with hard-disk storage that supports up to 30 students' workstations with graphics, animation and audio capabilities. The computer interfaced with each student individually. The software, WICAT Primary Reading curriculum, included interactive exercises and the reading outcomes required by the Oklahoma state in the United States of America. The study included 85 first graders enrolled in two elementary schools in Oklahoma, approximately half in a school with computers (experimental group) and the other half in a school with no computer facilities (control group). The two groups were matched for gender, socioeconomic status and reading skills at the beginning of the school year. Pre- and post-test scores were analyzed for both groups and the following findings emerged:

1. Extended use of CAI appears to significantly influence the development of reading skills in first graders (approximately 10 percent of variation in pre-post test change).
2. Boys in the experimental group showed statistically significant gains in reading skills compared to boys in the control group (at significance level of 0.01).
3. Although the girls in the experimental group showed improvements, their gains were not statistically significant when compared to girls in the control group.

Advocates of CAI have high expectations for the computer as an instrument for identifying and meeting individual needs aspirations. Many studies conclude that using CAI to supplement traditional instruction is better than the instructional programme itself.

Some researchers have tried to find out if students prefer computer-based methods simply because a computer is involved. Other research has focused on the computer's influence on student attitude toward school and curriculum. Bracey (1982) found that students reacted favourably to computer use for instructional tasks. He reported that students who worked on the computer had a more positive attitude toward the machine than those who had not used the computer. Kulik (2003) reviewed studies on students' attitude toward the curriculum after using CAI. In three of the studies reviewed, the results were statistically significant for the CAI classroom. Another common finding of studies in this area is that students usually develop a more positive attitude toward computers in general as a result of their exposure to CAI. In addition to this finding, however, Kulik (2003), surveying eleven (11) CAI studies involving college students found differences favouring the development of positive attitudes toward the subject matter as well as toward computers as a result of exposure to CAI. This same finding can be considered only as a tentative indication at this time; it certainly points toward a goal that faculty in general shares to motivate the students to want to learn more about their field on their own.

Christmann & Badgett (1997), did not find any difference in academic achievement between students who used calculators and microcomputer-based statistical analysis software. However, they did find an interaction effect showing that females performed better on statistical calculations when using handheld calculators as opposed to using microcomputer-based statistical analysis software.

In another study by Wenglinsky (1998), that focused on the relationship between technology characteristics and educational outcomes and also addressed the question of "what kind computer use has what kind of effect, on which groups of students". The researcher used a technique of structural equation modeling with four variables: (1) frequency of school computer use for mathematical tasks; (2) access to/ frequency of home computers use; (3) professional development of mathematics teachers in technology use; and (4) higher-order and lower-order use of computers by mathematics teachers and their students. Higher-order activities for fourth graders were learning games and for eighth graders were applications and simulations, while drill and practice were defined as lower-order use. Outcomes included academic achievement in mathematics and the social environment of school. Models were accepted when goodness of fit indices were better than .9 making results statistically significant at .05.

The findings were as follows:

1. The greatest inequities in the use of technology were related to how computers were used, rather than the frequency of use. For instance, for both fourth- and eighth-graders, mathematics teachers in urban and rural schools were less likely to have received professional development in technology over the last five years than teachers in suburban schools.
2. Academic achievement in mathematics and the social environment of the school were positively related to: teacher's professional development in technology, the use of computers to teach higher-order thinking skills; and the frequency of home computer use (eighth-graders only).
3. Academic achievement in mathematics was negatively related to: the frequency of school computer use; the frequency of home computer use (fourth-graders only); and the use of computers to teach lower-order thinking skills (eighth-graders only).

Summary

It is recognized by many nations that a shift from teacher-controlled towards more student-centered arrangements of the learning process can be facilitated by ICT. Until now the potentials of ICT have not been utilized in education in Ghana. We are just beginning. Many of the ICT applications available are used to facilitate teacher-controlled arrangements of the learning process. Applications of ICT must be adapted to the existing education beliefs and teaching routines, and not being used just as a substitute for other media.

The belief and attitudes of teachers towards their teaching practice must also change. It is important to note that the use of ICT as a substitution of current teaching and learning activities can be seen as the first of three phases through which the implementation of new technologies generally diffuses (Itzkan, 1994, p. 56). These phases according to (Itzkan, 1994), are: Substitution, Transition and Transformation.

The underlying rationale of the phases of technological diffusion is that it is a mistake to suppose that new technologies will continue to fit into existing practices. The other side of the coin is that when we continue to use ICT for substituting existing practices, ICT will not necessary contribute to solutions for today's seeming problems in education. It, therefore, means that conscious efforts are needed to plan activities to get over ICT use for the substitution phase and move to the transition. It is from there that we can use ICT to transform education and for that matter the economy thus being able to create wealth with ICT.

CHAPTER THREE

METHODOLOGY

Overview

The chapter discusses in detail the methods the researcher used for the study. These include the research design, the target population, the sample and sampling techniques, instrumentation, data collection procedures and data analysis.

Research Design

The study sought to find out the effects of computer-assisted instruction on the academic achievement of Senior High Schools students in Plane Geometry in the West Akim Municipality of the Eastern Region of the Republic of Ghana. There were experimental and control groups.

The research design involves quasi-experimental design. It involved non-equivalent comparison-group design which, is said to be among the most commonly used quasi-experimental designs. Structurally, the design is quite similar to the experimental design except that random assignments were not employed.

Again, in applying the non-equivalent pretest-posttest design the dependent variable was measured both before and after intervention as shown below.

NR-----O-----X_1-----O

NR-----O-----X_2-----O

That would enable the researcher to establish the temporal precedence of the independent variable over the dependent variable and measure between group differences before intervention. That development will give the researcher more confidence when making inference to the effect that the independent variable would be responsible or not for changes in the dependent variable. Again, it will enable the researcher to use the pretest to measure between the groups differences before exposure to the intervention, which might reduce substantially the threat of selection bias by revealing whether the groups differed on the dependent variable prior to the intervention.

Graziano and Raulin cited in Marczyk, DeMatteo & Festinger (2005), assert that "With careful analysis and cautious interpretation, non-equivalent comparison-group designs may still lead to some valid conclusions" (p. 153). Best & Khan (1995) assert that this design is used in classroom experiments when experimental and control groups are naturally assembled as intact groups that may be similar.

Population

The target population for the study was the set of students totaling 2,729 in the three (3) public SHS in the West Akim Municipality in the Eastern Region of the Republic of Ghana. These are:

1. Asamankese Senior High School – Mixed (1,523 students).
2. St. Thomas Secondary Technical School – Mixed (562 Students).
3. Adeiso Presby Senior High School – Mixed (644students).

Sample and Sampling Technique

The researcher picked the entire students in Agriculture Science one classrooms from the two selected schools as intact groups. A visit to the schools revealed that it is only Asamankese Senior High School that had computer laboratory and therefore the Agriculture Science students in the school were selected as the experimental group. The purposive sampling technique was used to select Adeiso Presby Senior High School as the control group instead of St. Thomas Senior Technical School. That was done in order to reduce the cross-over effects. Adeiso Presby Senior High School is twenty-five (25) kilometers away from Asamankese while St. Thomas is located at Asamankese Township.

The sample was made up all the students numbering one hundred and seven (107) in the first year studying Agricultural Science as a programme in the two selected senior high schools in the West Akim Municipality. The breakdown is as follows:

1. Asamankese Senior High School Form One (1) Agric. Science Students totaling 57 made up of 12 females and 45 males.
2. Adeiso Presby Senior High School Form One (1) Agric. Science Students totaling 50 made up of 9 females and 41 males.

Instrumentation

The main instrument for the study was a Plane Geometry Test based on the Senior High School 1 syllabus. The thirty-item (30) paper and pencil test was developed by the researcher. The content validity was established by subjecting the contents to colleagues in the ICT class who read through the first and second drafts and made valuable suggestions. The third draft was given to a Mathematics teacher at Wesley Girls High School in Cape Coast, Ghana. He also read through and came out with suggestions which were incorporated before it was laid before the supervisor. The supervisor in turn made very useful suggestions leading to the deletion of some symbols which were used to represent angles and replaced with others which were not controversial in nature.

Pilot Testing

The pilot test took place at Suhum Secondary Technical School in the Suhum Kraboa Coaltar District in the Eastern Region. Suhum was chosen because it is about thirty-four kilometers away from Asamankese and has similar characteristic as the West Akim Municipality. The pilot test was done to ascertain the item difficulty, item discrimination and item reliability for each item as well as the entire instrument. The result showed about six items with item difficulty less than 0.3. However, the Cronbach's Alpha was 0.8 and above while the Cronbach's Alpha Based on Standardized Items was also 0.887 on all the thirty items as per Appendix 1.

Data Collection Procedure

Data were collected by the researcher himself through the Non-Equivalent Group Design (NEGD) pretest-posttest procedure. As indicated earlier on, the two schools selected were Adeiso Presby Senior High School and Asamankese Senior High School. The researcher first visited the sample schools and had fruitful discussions on why their schools were chosen among others. Both headmasters were known to the researcher and that made it possible to get in touch with the subject teachers concerned. The next step was to negotiate for a three-hour a day that would enable the researcher to undertake the three-pronged process of pre-test of the instrument followed by intervention and finally the posttest. At both schools the respondents were informed about the purpose of the study as purely an academic exercise. That enabled to respondents to co-operate beyond reasonable measure with the researcher.

At Adeiso the pretest was administered first to the respondents involved in the study. That was followed by one hour intervention in the traditional teaching and the posttest. At Asamankese, the researcher visited the school the previous day and installed the tutorial on the school's sixty (60) computers with a code on them which made it impossible for the students to access. On the day itself, the researcher explained the purpose of the research to the respondents just as the researcher had done at Adeiso Presby Senior High School. That was done in order to clarify any doubts or unclear issues to the respondents before the pretest was administered. The pretest was preceded by the teaching of some basic computer navigations that were to be used in the computer-assisted instruction in learning the content or package. The pretest was administered and collected after which the respondents had a ten-minute break. That was followed by the intervention which took one hour and followed immediately with the posttest.

Data Analysis

The data collected from the pretest-posttest from the control and experimental groups were first coded into the computer which enabled the analysis to be carried out using the two-sample Independent Student t-distribution by employing the Statistical Programme for Social Sciences (SPSS). The data analysis was done based on the research questions to find out if there were significant differences between the academic performance of the groups as well as between males and females in Plane Geometry.

The significance of difference between the means scores of both groups on the pretest-posttest scores was tested at the level of 0.05 by employing the independent sample t-test. Again, to verify the intervention effects on the male and female students of the groups the independent sample t-test was applied.

CHAPTER FOUR

RESULTS AND DISCUSSION

Overview

This chapter deals with discussion of data and presentation of the results and findings of the study. The Statistical Programme for Social Sciences (SPSS) software was employed to determine the relationship between the hypotheses. Two comparable classrooms from two different schools which were as similar as possible were purposefully selected for the study to make fair comparison between the experimental and control groups. The independent-sample t-test statistic was used to test the hypotheses at significance level of 0.05.

Research Question One:

What are the effects of computer-assisted instruction on the academic achievement of SHS students studying Plane Geometry in the West Akim Municipality?

Table 2 shows the means between the control group and the experimental group after both the Pretest and Posttest. It also indicates standard deviation differences between the control and experimental groups after both the Pretest and Posttest. In addition, the number of respondents in each case was 50 and 57 for the control group and experimental group.

Table 2: Mean and Standard Deviation Differences

	Name of Group	N	Mean	Std. Deviation	Std. Error Mean
Pretest	Control Group	50	15.46	4.62	.65
	Exp. Group	57	16.44	4.74	.63
Posttest	Control Group	50	19.62	4.65	.66
	Exp. Group	57	21.86	4.41	.58

In Table 2, the pretest mean for the control and experimental groups were 15.46 and 16.44 with standard deviations of 4.62 and 4.74 respectively. The results from the pretest in the group statistics showed that the experimental group scored slightly higher than the control group with a mean difference of 0.98 points in the pretest. This means the groups were homogeneous at the beginning of the study.

However, in the posttest, there was a marginal 2.24 point difference between the means. This means that the intervention did improve performance and therefore can be concluded that the computer-assisted instruction had a marginal effect on the academic achievement of students studying Plane Geometry.

Research Hypothesis One:

"There is no significant difference between the academic achievement of students exposed to computer-assisted instruction and those not exposed to Plane Geometry".

The data in Tables 2 and 3 were used to test Hypothesis One. The data in Table 3 indicates that both Control and Experimental groups differ in the pretest mean scores with .98 point difference. They also differ in their standard deviation scores. However, the difference between the Control and Experimental groups in the pretest was not significant at level .05. In Table 3, the t(-1.078), df(105) and (p=.283).

Again, the data in Table 2 indicates that both Control and Experimental groups differ in the posttest mean scores with 2.24 point difference. They also differ in their standard deviation scores. However, the difference between the Control and Experimental groups in the posttest was significant at .05 levels. In Table 3, the t (-2.556), df(105) and (p=.012).

Table 3: Independent Sample T-test by Groups

		T-test for Equality of Means			
		t	df	Sig. 2-tailed	Mean Difference
Pretest	Equal Variances assumed	-1.078	105	.283	-.98
	Equal variances not assumed	-1.080	103.848	.283	-.98
Posttest	Equal Variances assumed	-2.556	105	.012	-2.24
	Equal variances not assumed	-2.547	101.483	.012	-2.24

However, when the t-values were computed it yielded a t-value of (-1.078), df(105) and sig. value of p=.283. The conclusion is that there was no significant difference between experimental and control groups in the pretest. When the t-values were computed it was evident that the performance of the experimental group was significantly better than the control group as evidenced by the independent student t-test. The t (-2.556) df (105) and the significant value of p = .012 as shown in Table 3 is a clear indication that the difference between the two means was statistically significant at 0.05 levels.

Thus the hypothesis on research question one that "There is no significant difference between the academic achievement of students exposed to computer-assisted instruction and those not exposed to in the study of Plane Geometry" is rejected at 0.05 level. It therefore, means that there was a significant difference between the academic achievement of students exposed to computer-assisted instruction and those not exposed to in the study of Plane Geometry.

Using the Eta squared statistic to determine the effect size in the magnitude of the differences between the groups, the effect size of the difference between the groups is 0.06 and this according to Cohen (1988), is moderate.

Research Question Two:

What are the effects of computer-assisted instruction on academic achievement of female and male Senior High School students studying Plane Geometry in West Akim Municipality?

Table 4 shows the means between the male and the female after both the Pretest and Posttest. It also indicates standard deviation differences between the male and female after both the Pretest and Posttest. In addition, the number of respondents in each case was 86 and 21 for the male and female.

Table 4: Mean and Standard Deviation Differences by Gender

	Name of Group	N	Mean	Std. Deviation	Std. Error Mean
Pretest	Male	86	16.01	4.79	.52
	Female	21	15.86	4.37	.95
Posttest	Male	86	21.01	4.52	.49
	Female	21	20.00	5.15	1.12

In Table 4, the female and male pretest mean scores were 15.86 and 16.01 while the SD = 4.37 and 4.79 respectively. Again, in the posttest, the mean scores were 20.00 and 21.01 and standard deviations of 45.15 and 4.52 respectively. The magnitude of the effect size using Eta squared was 0.007. This according to Cohen (1998), is less than 0.01 and can be described as very small effect. It can be concluded therefore, that computer-assisted instruction has no effect on the academic achievement of female and male students in the study of Plane Geometry.

Research Hypothesis Two:

"There is no significant between the academic achievement of female and male students exposed to computer-assisted instruction and those not exposed to in the study of Plane Geometry".

The data in Tables 4 and 5 were used to test hypothesis two. The data in Table 4 shows that both the female and male students differ in the pretest with .15 and .42 point differences on both the means and standard deviations respectively. When the t-values were computed on the pretest, the t-value was t

(.135), df (105) and significant value of p = .893, (Table 5). This shows that there was no significant difference between the academic achievement of females and males students exposed to computer-assisted instruction and those not exposed to in the study of Plane Geometry.

In the posttest, the difference in the mean and standard deviation scores were 1.01 and 1.37 respectively as shown in Table 5. When the t-values were computed as in Table 5 the t-value was t (.135), df (105) and a significant value of p = .373 respectively. Again, it was evident in the posttest that there was no significant difference between the female and male SHS students exposed to computer-assisted instruction and those not exposed to in the study of Plane Geometry.

Table 5: Independent Sample T-test by Gender

		T-test for Equality of Means			
		t	df	Sig. 2-tailed	Mean Difference
Pretest	Equal Variances assumed	.135	105	.893	.15
	Equal variances not assumed	.142	32.747	.888	.15
Posttest	Equal Variances assumed	.895	105	.373	1.01
	Equal variances not assumed	.826	27.988	.416	1.01

From Tables 4 and 5, it is clear that there was no significant difference between the female and male achievement scores after being exposed to computer-assisted instruction and those not exposed to in the study of Plane Geometry. The following details indicated that there was no significant difference in the females (M = 15.86, SD = 4.37) and males (M = 16.01, SD = 4.79), t (.895) df (105), p = .373.

Therefore the Hypothesis Two that "There is no significant difference between the academic achievement of the female and male students exposed to computer-assisted instruction and those not exposed to in the study of Plane Geometry is not rejected at 0.05 level.

It, therefore, means that there is no significant difference in the academic achievement of female and male student exposed to computer-assisted instruction and those not exposed to in the study of Plane Geometry.

Summary of Findings

From the analysis of data gathered, the following summary of findings is arrived at:

1. There is a significant difference between the academic achievement of SHS students exposed to computer-assisted instruction and those not exposed to in the study of Plane Geometry.
2. There is no significant difference between the academic achievement of SHS female and male students exposed to computer-assisted instruction and those not exposed to in the study of Plane Geometry.

Discussion of Findings

In this section, the findings are based on the whether they confirm or disagree with the reviewed theoretical and empirical studies. The results are discussed in relation to the research hypothesis. The results of the pretest which showed that there was no significant difference between the experimental group and the control group affirms that the groups were homogenous at the beginning the study. In other words before the experimental group were exposed to the intervention, the groups were similar in spite of the slight difference in means.

However, when the experimental group was exposed to the intervention or CAI, the differences, as compared to the control group who received the traditional method of instruction, were marginally significant. This means that the intervention improved the performance of the experimental group more than the control group.

This finding is affirmed by the study undertaken by Erdner, Guy & Bush (1998), which examined effects of computer-assisted instruction on the reading skills of first graders. Pretest and posttest scores were analyzed for both groups and the study concluded that although girls in the experimental group showed improvements, their gains were not statistically significant when compared to the girls in the control group.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter deals with the summary of the research findings, conclusions, implications and recommendations. In addition, the chapter suggests areas for further research.

Summary

The purpose of the study was to find out the effects of Computer-Assisted Instruction on the academic achievement of SHS students in Mathematics. It also investigated whether gender has any effect on the academic achievement of students exposed to Computer-Assisted Instruction and those not exposed to such instruction.

After review of related literature, the quasi experimental group design or the non-equivalent group design was employed as the research design. It was a simple pretest-posttest two group design. The sample consisted of one hundred and seven (107) first year Agricultural Science Students. The breakdown was Asamankese Senior High School, 57 and Adeiso Presby Senior High School 50. There were 21 females and 86 males.

A test based on Plane Geometry 1 syllabus of the SHS was used as the main instrument for the data collection. The Computer-Assisted Instruction was a tutorial based on Plane Geometry 1 syllabus. It was pilot tested at Suhum Senior Secondary Technical High School which has similar characteristics as the two selected High Schools in the West Akim Municipality. The pilot test produced a reliability coefficient of .89. The Independent-sample t-test was used to test the Hypothesis at 0.05 levels of significance.

Key Findings

The study revealed the following results:

1. There is a significant difference between the academic achievement of SHS student who were exposed to Computer-Assisted Instruction and those not exposed to in the study of Plane Geometry.
2. There is no significant difference between academic achievement of female and male SHS students exposed to Computer-Assisted Instruction and those not exposed to in the study of Plane Geometry.

Conclusions

From the analysis of the study it is concluded that “There is significant difference between the academic achievement of SHS students exposed to Computer-assisted Instruction and those who are not exposed to such instruction in the study of Plane Geometry. Furthermore, the study revealed that gender has no significant effect on the academic achievement of SHS students exposed to Computer-Assisted instruction and not exposed to such instruction in the study of Plane Geometry.

Implications

The findings of the study have several educational implications for policy makers, school administrators, teachers, parents as well as students. Since the exposure to Computer-Assisted Instruction can improve the academic achievement of students, it is imperative for school administrators, teachers, parents and students to make a strong case for policy makers and for that matter the government to intervene by looking for the required resources to provide the necessary facilities towards the realization of Information Communication Technology (ICT) in education. Such a bold attempt will enable the country to realize the numerous benefits that ICT brings to our fledging economy.

There is also an urgent need to for the Ghana Education Service (GES) to collaborate with the Public Universities to establish ICT centers that will focus on the training teachers in ICT to integrate Computer-Assisted Instruction in their daily routine teaching to improve the learning processes especially in the Senior High Schools (SHS).

Recommendations

In the light of the findings of the study and its implications, the following recommendations are made:

1. To streamline the production and use of Computer-Assisted Instruction by teachers the Ghana Education Service (GES) should commission a team of experts to produce CAI based on the SHS syllabuses to make such instructions uniform.
2. The products of such venture should be made available to the general public to purchase and use them.

3. The GES should liaise with the Universities so that competent teachers could be trained to handle the ever-increasing computer knowledge-based education in order to reap the numerous benefits Ghana stands to gain in the ICT education.

Areas for Further Research

To further extend the impact of Computer-Assisted Instruction (CAI) on the subject of Mathematics, the following recommendations for further studies are provided:

1. The study should be extended to all programmes of the SHS syllabuses especially the Arts, Technical and Agriculture.
2. A study could also be carried out in a unisex senior high school setting to see whether gender in this context can impact on the academic achievement of students when exposed to CAI in the study of Mathematics.

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APPENDIX A

Test Item Reliability Analysis

R E L I A B I L I T Y   A N A L Y S I S -S C A L E (A L P H A)

1.	HALF	A half turn
2.	COMPLE	A complete turn
3.	TWO	Two complete turns
4.	THREE	Three and half turns
5.	TYPE	What is the type of angle in figure 1?
6.	NAME	What is the name of the angle in figure
7.	VALUE	What is the value of the letter d in fig
8.	CAL	Calculate the value of the letter e in f
9.	FIND	Find the value of the letter f in figure
10.	ANGLEX	Calculate the value of t in figure 4 if
11.	LETTERP	Find the value of the letter p?
12.	ETEPQ	What is the value of the letter q?
13.	LETTERR	Calculate the value of the letter r?
14.	LETTERX	What is the value of the letter x?
15.	LETTERY	Find the value of the letter y?
16.	LETTERZ	Calculate the value of the letter z?
17.	FIGUREP	What is the value of the letter p in fig
18.	FIGUREQ	Calculate the value of the letter q in f
19.	FIGURER	Find the value of the letter r in figure
20.	FIGURES	What is the value of the letter s in fig
21.	VALUEX	Find the value of x in the figure 7?
22.	VALUEXX	What is the value of x in the figure 7?
23.	VALUEXXX	Calculate the value of xxx in the figure
24.	VALUEY	What is the value of y in the figure 10?
25.	CALCUY	Calculate the value of y in the figure 1
26.	ADDUP	Two angles which add up to 180 are known
27.	GREATER	An angle greater than 180 but less than
28.	LESS	An angle greater than 180 but less than
29.	COMMON	Two angles with a common vertex and comm

30. SUM The sum of the interior opposite angle

R E L I A B I L I T Y   A N A L Y S I S - S C A L E (A L P H A)

		Mean	Std Dev	Cases
1.	HALF	.7895	.4132	38.0
2.	COMPLE	.7895	.4132	38.0
3.	TWO	.7895	.4132	38.0
4.	THREE	.8421	.3695	38.0
5.	TYPE	.9211	.2733	38.0
6.	NAME	.8684	.3426	38.0
7.	VALUE	.9211	.2733	38.0
8.	CAL	.9211	.2733	38.0
9.	FIND	.8421	.3695	38.0
10.	ANGLEX	.8947	.3110	38.0
11.	LETTERP	.8158	.3929	38.0
12.	ETEPQ	.8158	.3929	38.0
13.	LETTERR	.8158	.3929	38.0
14.	LETTERX	.8421	.3695	38.0
15.	LETTERY	.8158	.3929	38.0
16.	LETTERZ	.8684	.3426	38.0
17.	FIGUREP	.7368	.4463	38.0
18.	FIGUREQ	.8421	.3695	38.0
19.	FIGURER	.8947	.3110	38.0
20.	FIGURES	.7895	.4132	38.0
21.	VALUEX	.8158	.3929	38.0
22.	VALUEXX	.8684	.3426	38.0
23.	VALUEXXX	.8421	.3695	38.0
24.	VALUEY	.8684	.3426	38.0
25.	CALCUY	.8684	.3426	38.0
26.	ADDUP	.8684	.3426	38.0
27.	GREATER	.7895	.4132	38.0
28.	LESS	.8158	.3929	38.0
29.	COMMON	.8158	.3929	38.0

30.	SUM	.8421	.3695	38.0

R E L I A B I L I T Y   A N A L Y S I S - S C A L E (A L P H A)

Item-total Statistics

	Scale Mean if Item Delete	Scale Variance if Item Delete	Corrected Item-Total Correlation	Alpha if Item Deleted
HALF	24.4211	26.3585	.5016	.8823
COMPLE	24.4211	26.2504	.5282	.8817
TWO	24.4211	25.9260	.6086	.8798
THREE	24.3684	26.1849	.6176	.8800
TYPE	24.2895	27.9950	.2032	.8878
NAME	24.3421	27.4744	.2967	.8866
VALUE	24.2895	27.2383	.4713	.8836
CAL	24.2895	28.1572	.1467	.8886
FIND	24.3684	26.4552	.5433	.8816
ANGLEX	24.3158	26.6003	.6110	.8809
LETTERP	24.3947	25.9211	.6454	.8791
ETEPQ	24.3947	25.8670	.6596	.8788
LETTERR	24.3947	26.0832	.6030	.8801
LETTERX	24.3684	27.9687	.1412	.8899
LETTERY	24.3947	26.7319	.4359	.8838
LETTERZ	24.3421	27.4203	.3120	.8863
FIGUREP	24.4737	26.5804	.4081	.8847
FIGUREQ	24.3684	27.5903	.2396	.8879
FIGURER	24.3158	27.8976	.2018	.8881
FIGURES	24.4211	26.1963	.5415	.8814
VALUEX	24.3947	25.9751	.6312	.8794
VALUEXX	24.3421	26.0690	.7063	.8785
VALUEXXX	24.3684	28.0228	.1273	.8902
VALUEY	24.3421	26.9879	.4360	.8839
CALCUY	24.3421	27.0960	.4048	.8845
ADDUP	24.3421	27.5284	.2813	.8869
GREATER	24.4211	26.5747	.4488	.8836
LESS	24.3947	27.7048	.1930	.8892
COMMON	24.3947	26.3535	.5329	.8817
SUM	24.3684	27.2660	.3251	.8861

Reliability Coefficients

N of Cases = 38.0   N of Items = 30

Alpha = .8874

****** Method 1 (space saver) will be used for this analysis ******

APPENDIX B

Test Item Difficulty Analysis

	q1	q2	q3	q4	q5	q6	q7
1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1
5	0	1	1	1	1	1	1
6	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1
10	1	0	1	1	1	1	1
11	1	1	1	1	1	1	1
12	0	1	1	1	1	1	1
13	1	1	1	1	1	0	1
14	1	1	1	1	1	1	1
15	1	1	1	1	1	1	1
16	1	1	1	1	1	0	0
17	1	1	1	1	1	1	1
18	1	1	1	1	1	1	1
19	1	1	1	1	1	1	1
Upper Total	**17**	**18**	**19**	**19**	**19**	**17**	**18**
20	1	0	0	1	1	1	1
21	0	1	1	1	1	1	1
22	1	1	1	1	0	1	1
23	1	1	1	1	1	1	1
24	1	1	1	1	1	1	1
25	1	1	0	1	1	1	1
26	1	1	1	1	0	1	1
27	1	1	1	1	1	0	1
28	1	1	1	1	1	1	1
29	1	0	0	0	1	1	1
30	1	1	1	0	1	1	1
31	0	0	1	1	1	1	1
32	1	1	1	1	1	1	1
33	1	1	1	0	1	1	1
34	1	0	0	0	1	1	1
35	0	1	0	1	1	1	1
36	0	0	0	1	1	1	1
37	0	0	0	0	1	0	0
38	0	0	0	0	0	0	0
Lower Total	**13**	**12**	**11**	**13**	**16**	**16**	**17**
Grand Total	**30**	**30**	**30**	**32**	**35**	**33**	**35**
Item Diffi. Level	**78.9473**	**78.9473**	**78.9473**	**84.2105**	**92.1052**	**86.8421**	**92.1052**

Diffi. Index 0.2105 0.2631 0.3684 0.3157 0.1578 0.0526 0.0526

q8	q9	q10	q11	q12	q13	q14	q15	q16
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	0	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1
1	1	1	1	1	1	0	1	1
1	1	1	0	1	1	1	1	1
1	1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	0	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	0	1	1
1	0	1	1	1	1	1	1	1
1	1	1	1	1	0	1	1	1
18	**18**	**19**	**18**	**18**	**18**	**17**	**18**	**18**
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	0	1
0	1	0	1	1	1	1	1	1
1	1	1	1	1	1	0	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	0	1	1	1
1	1	1	1	1	1	0	1	1
1	1	1	1	0	1	1	1	1
1	1	1	0	1	0	1	0	0
1	0	1	0	1	1	0	1	1
1	1	1	1	0	1	1	0	1
1	0	1	0	1	0	1	0	1
1	0	1	0	0	1	1	0	0
1	0	0	1	0	0	1	1	1
0	0	0	0	0	0	0	1	1
1	1	0	0	0	0	1	0	0
17	**14**	**15**	**13**	**13**	**13**	**15**	**13**	**15**
35	**32**	**34**	**31**	**31**	**31**	**32**	**31**	**33**
92.105	**84.210**	**89.473**	**81.5789**	**81.5789**	**81.5789**	**84.210**	**81.578**	**86.842**
0.0526	**0.2105**	**0.1578**	**0.3157**	**0.3157**	**0.3157**	**0.1578**	**0.2105**	**0.1578**

q17	q18	q19	q20	q21	q22	q23	q24	q25
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	0	1	1
0	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	0	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
1	1	1	1	0	1	1	1	1
1	1	1	1	1	1	1	0	1
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1
16	**18**	**19**	**19**	**18**	**19**	**18**	**18**	**19**
1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	0	1	1
1	1	1	0	1	1	1	1	1
1	1	1	1	1	1	1	1	0
1	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1
1	0	1	1	1	1	0	1	1
1	1	0	1	1	1	1	1	1
0	1	1	0	1	1	1	1	0
1	1	1	1	1	1	1	1	1
1	0	1	0	0	1	0	1	1
1	0	0	1	1	1	1	1	1
0	1	0	0	0	0	1	0	1
0	1	0	1	0	0	1	1	0
1	1	1	0	1	1	0	0	1
1	0	1	0	1	0	1	0	1
0	0	1	0	0	1	0	1	0
0	1	1	0	0	0	1	1	0
0	1	1	1	0	0	1	0	1
12	**14**	**15**	**11**	**13**	**14**	**14**	**15**	**14**
28	**32**	**34**	**30**	**31**	**33**	**32**	**33**	**34**
73.684	**84.2105**	**89.4736**	**78.9473**	**81.578**	**86.842**	**84.210**	**86.842**	**86.842**
0.3157	**0.105263**	**0.15789**	**0.42105**	**0.3157**	**0.2105**	**0.2631**	**0.1578**	**0.2105**

q26	q27	q28	q29	q30	Total
1	1	1	1	1	30
1	1	1	1	1	30
1	1	1	1	1	30
1	1	1	1	1	30
1	1	1	1	1	29
1	1	1	1	1	29
1	1	1	1	1	29
1	1	1	1	1	29
1	1	1	1	1	29
1	1	1	1	1	29
1	1	1	1	1	29
1	1	1	1	1	28
1	1	1	1	1	28
1	1	1	1	1	28
1	1	1	1	1	28
1	1	1	1	1	28
1	0	1	1	1	28
1	1	1	1	1	28
1	1	1	1	1	28
19	**18**	**19**	**19**	**19**	
1	1	1	1	1	28
1	1	0	1	1	27
1	0	1	1	1	26
1	1	1	0	0	26
0	1	0	1	1	26
1	1	0	1	1	26
1	1	0	1	1	26
1	0	1	1	0	26
0	1	1	1	1	25
0	1	1	0	1	24
1	1	0	0	1	22
1	0	1	1	0	20
1	1	1	0	1	20
1	1	0	0	0	19
0	0	1	1	1	18
1	0	1	1	0	17
1	0	1	1	0	15
1	1	0	0	1	10
0	0	1	0	1	10
14	**12**	**12**	**12**	**13**	
34	**30**	**31**	**31**	**32**	
86.84211	**78.94737**	**81.57895**	**81.57895**	**84.21053**	
0.263158	**0.368421**	**0.315789**	**0.368421**	**0.315789**	

APPENDIX C

PRE-TEST QUESTIONNAIRE

This pretest questions is part of a purely academic research being undertaking by a graduate student of the Centre for Continuing Education of the University of Cape Coast. The questionnaire is in two parts. The first part, comprise the Bio-data section while the second part consists of 30 questions with multiple answers. There is no way you can be identified and your responses would be treated with utmost confidentiality. Your co-operation is very much appreciated.

PART 1

BIO-DATA SECTION

Instructions:

Where square brackets are provided you tick e. g. [√]. Where options a., b., c., and d., are provided you circle the correct option e.g. ©. Where no responses are provided, please, do well to provide the answer.

Name of School…………………………………………………

Sex : Male [ ] Female [ ]

Program of Study………………………………………………………

Age:

15 years [ ]

16 years [ ]

17 years [ ]

18 years [ ]

19 years [ ]

20 years and above [ ]

PART 2

THE PRE-TEST

Instructions: Circle the letter of the Correct Answer

How many right angles are there in the following turns?

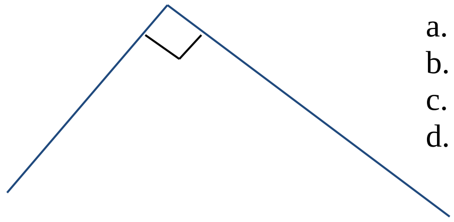
1. A half turn.
   a. 2
   b. 3
   c. 4
   d. 1

2. A complete turn.
   a. 1
   b. 3
   c. 2
   d. 4

3. Two complete turns.
   a. 2
   b. 4
   c. 6
   d. 8

4. Three and half turns.
   a. 18
   b. 16
   c. 14
   d. 12

5. What is the type of angle in figure 1?



a. An acute angle
b. A reflex angle
c. A right angle
d. An obtuse angle

Figure 1:

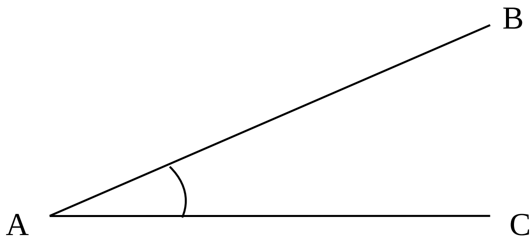


Figure 2:

6. What is the name of the angle BAC in figure 2?

   a. A right angle
   b. An obtuse angle
   c. An acute angle
   d. A reflex angle

Use figure 3 to answer questions 7 -9. The lines AB and CD are two straight lines.

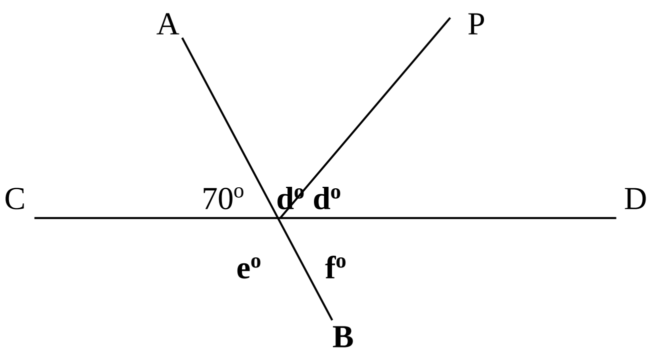


Figure 3:

7. What is the value of the letter **d in figure 3**?

   a. 40^o
   b. 45^o
   c. 55^o
   d. 50^o

8. Calculate the value of the letter **e in figure 3**?

   a. 110^o
   b. 120^o
   c. 100^o
   d. 80^o

9. Find the value of the letter **f in figure 3**?

a. 80^o
b. 70^o
c. 60^o
d. 100^o

10. Calculate the value of **t** in **figure 4** if angle X is 65^o. a. 25^o b. 30^o c. 10^o d. 15^o

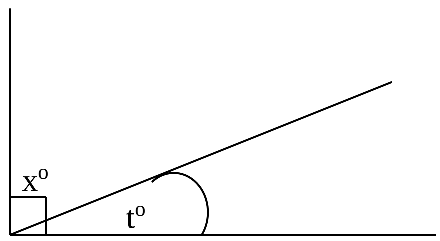


Figure 4:

Use figure 5 to answer questions 11 to 16. The lines PQ and ST are parallel lines.

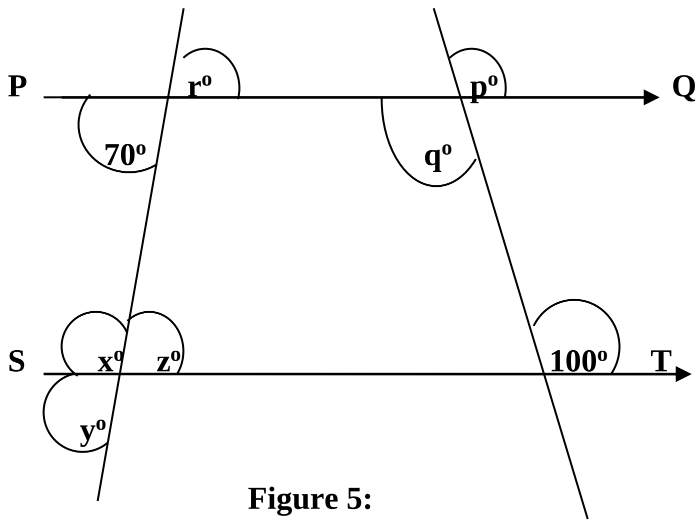


Figure 5:

11. Find the value of the letter **p**? a. 110^o b. 90^o c. 70^o d. 100^o

12. What is the value of the letter **q**? a. 110^o b. 90^o c. 70^o d. 100^o

13. Calculate the value of the letter **r**? a. 110^o b. 90^o c. 70^o d. 100^o

14. What is the value of the letter **x**? a. 110^o b. 90^o c. 70^o d. 100^o

15. Find the value of the letter **y**? a. 110^o b. 90^o c. 70^o d. 100^o

16. Calculate the value of the letter **z**? a. 110^o b. 90^o c. 70^o d. 100^o

Use figure 6 to answer questions 17 to 20. The lines AB and CD are parallel lines

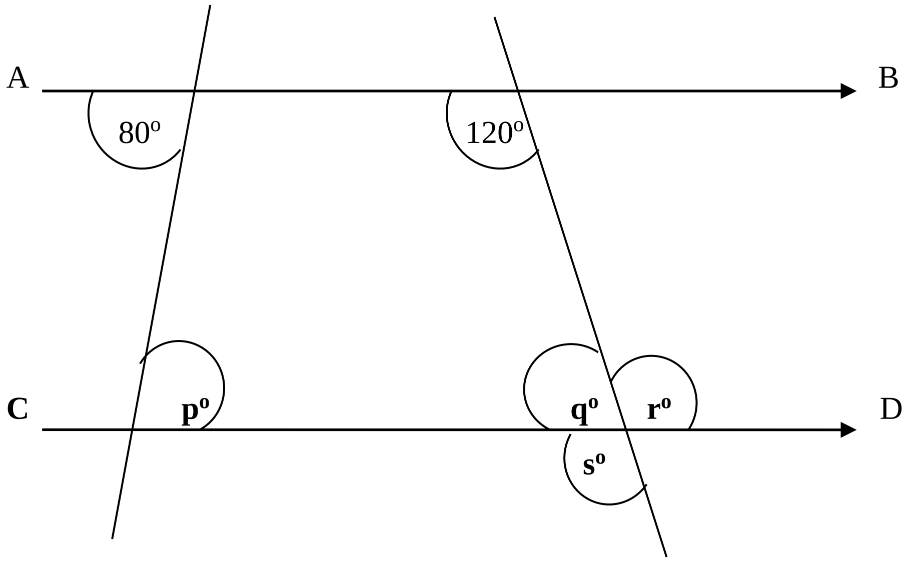


Figure 6:

17. Find the value of the letter **p** in figure 6? a. 80° b. 60° c. 120° d. 100°

18. Find the value of the letter **q** in figure 6? a. 80° b. 60° c. 100° d. 120°

19. Find the value of the letter **r** in figure 6? a. 80° b. 60° c. 120° d. 100°

20. Find the value of the letter **s** in figure 6? a. 80° b. 60° c. 100° d. 120°

Find the values of X in figures 7 to 9.

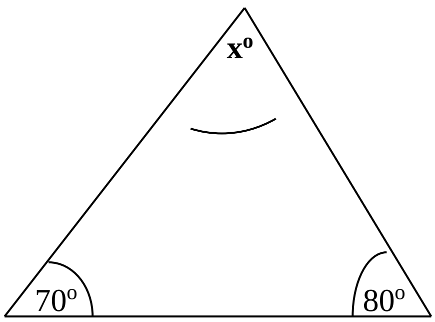


Figure 7:

21. Find the value of X in the figure 7.

a. 60°

b. 50°

c. 40°

d. 30°

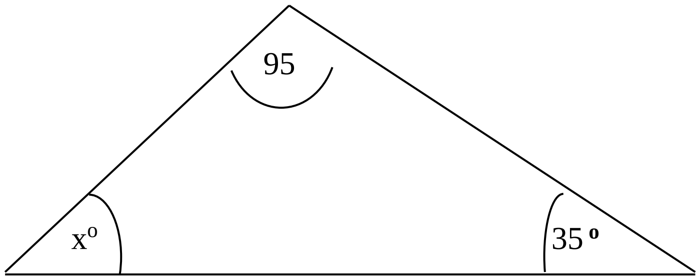


Figure 8:

22. What is the value of X in figure 8?

    a. 40^o

    b. 60^o

    c. 50^o

    d. 45^o

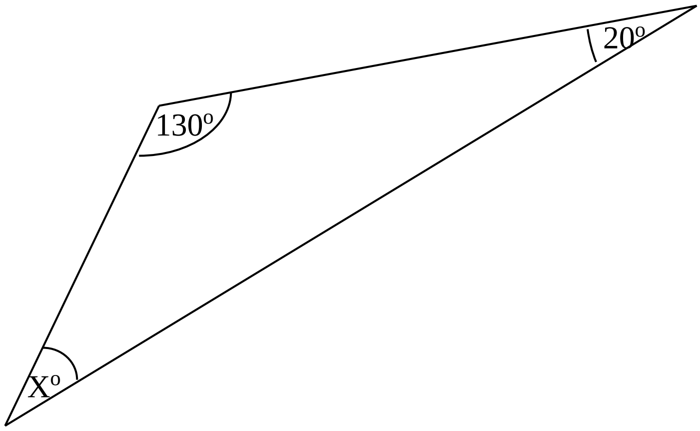


Figure 9:

23. Calculate the value of X in figure 9?

    a. 30^o

    b. 50^o

    c. 40^o

    d. 20^o

Calculate the values of Y in figures 10 to 11.

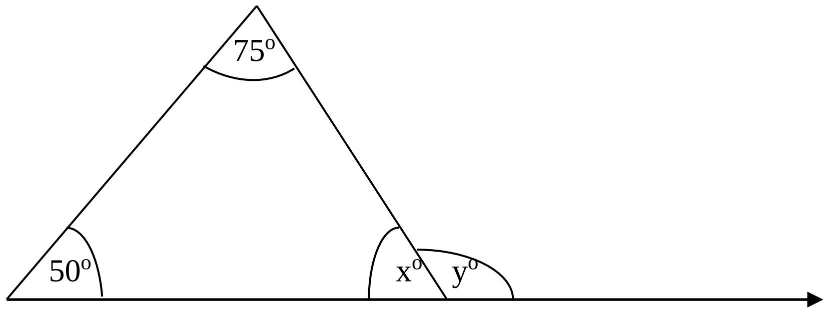


Figure 10:

24. What is the value of Yin figure 10?

   a. 55°
   b. 85°
   c. 120°
   d. 125°

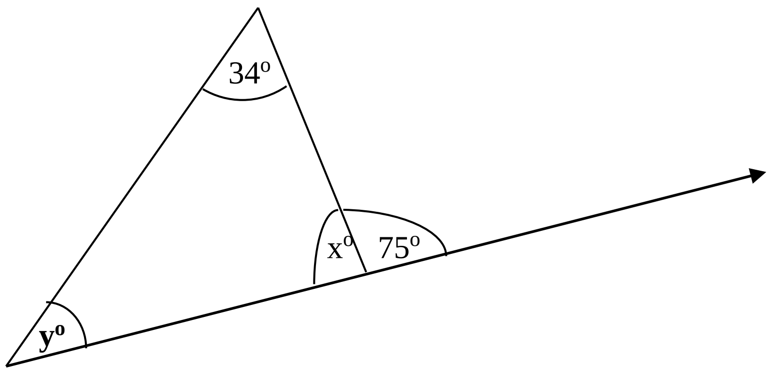


Figure 11:

25. Calculate the value of Y in figure 11.

   a. 41°
   b. 39°
   c. 37°
   d. 51°

26. Two angles which add up to 180^o are known as supplementary.
    a. True
    b. False

27. An angle greater than 180^o but less than 270^o is obtuse.
    a. True
    b. False

28. An angle greater than 180^o but less than 360^o is reflex.
    a. True
    b. False

29. Two angles with a common vertex and common sides are adjacent angles.
    a. True
    b. False

30. The sum of the interior opposite angles of a triangle is equal to the exterior angle of a triangle when one side of the triangle is extended.
    a. True
    b. False

APPENDIX D

POST-TEST QUESTIONNAIRE

This posttest questions is part of a purely academic research being undertaking by a graduate student of the Centre for Continuing Education of the University of Cape Coast. The questionnaire is in two parts. The first part, comprise the Bio-data section while the second part consists of 30 questions with multiple answers. There is no way you can be identified and your responses would be treated with utmost confidentiality. Your co-operation is very much appreciated.

PART 1

BIO-DATA SECTION

Instructions:

Where square brackets are provided you tick e. g. [√]. Where options a., b., c., and d., are provided you circle the correct option e.g. ©. Where no responses are provided, please, do well to provide the answer.

Name of School…………………………………………………………

Sex : Male [ ] Female [ ]

Program of Study……………………………………………………………

Age:

15 years [ ]

16 years [ ]

17 years [ ]

18 years [ ]

19 years [ ]

20 years and above [ ]

PART 2

THE POST-TEST

Instructions: Circle the letter of the Correct Answer

How many right angles are there in the following turns?

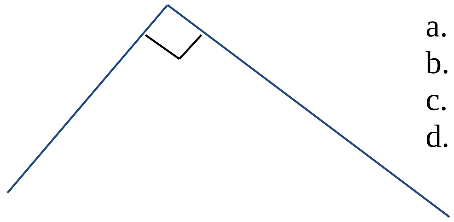
1. A half turn.
   a. 2
   b. 3
   c. 4
   d. 1

2. A complete turn.
   a. 1
   b. 3
   c. 2
   d. 4

3. Two complete turns.
   a. 2
   b. 4
   c. 6
   d. 8

4. Three and half turns.
   a. 18
   b. 16
   c. 14
   d. 12

5. What is the type of angle in figure 1?



a. An acute angle
b. A reflex angle
c. A right angle
d. An obtuse angle

Figure 1:

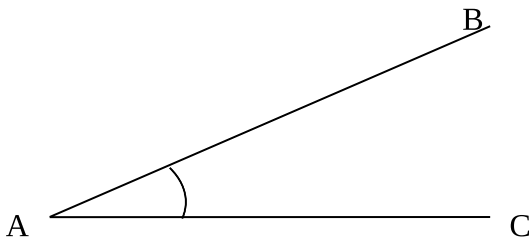


Figure 2:

6.What is the name of the angle BAC in figure 2?

a. A right angle
b. An obtuse angle
c. An acute angle
d. A reflex angle

Use figure 3 to answer questions 7 -9. The lines AB and CD are two straight lines.

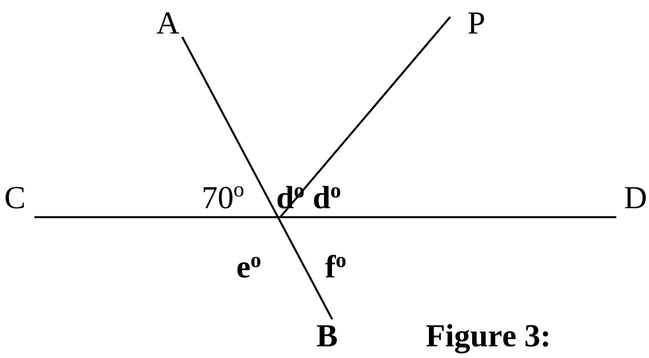


Figure 3:

7. What is the value of the letter **d in figure 3**?

   a. 40^o
   b. 45^o
   c. 55^o
   d. 50^o

8. Calculate the value of the letter **e in figure 3**?

   a. 110^o
   b. 120^o
   c. 100^o
   d. 80^o

9. Find the value of the letter **f in figure 3**?

a. 80^o
b. 70^o
c. 60^o
d. 100^o

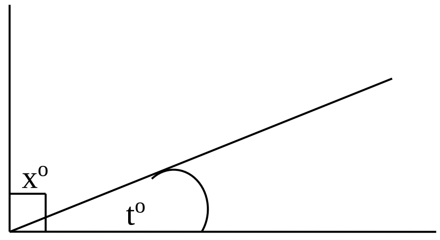


Figure 4:

10. Calculate the value of **t** in **figure 4** if angle X is 65^o.

a. 25^o b. 30^o c. 10^o d. 15^o

Use figure 5 to answer questions 11 to 16. The lines PQ and ST are parallel lines.

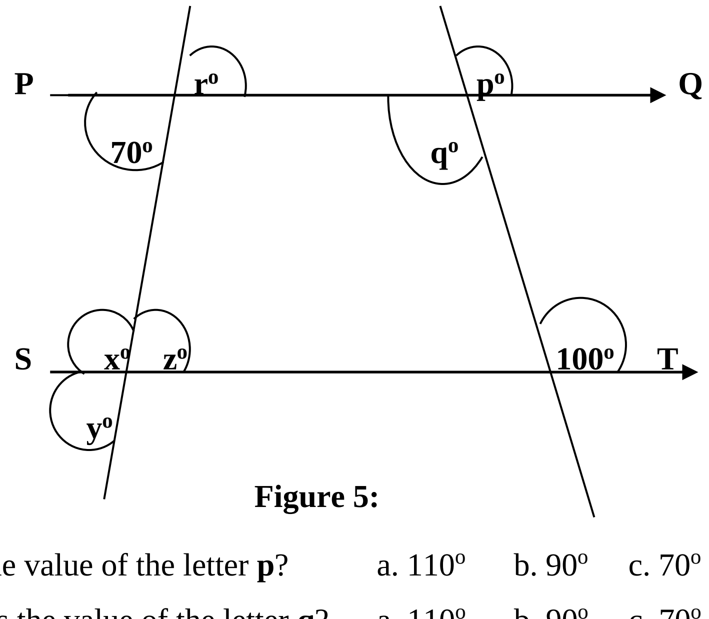


Figure 5:

11. Find the value of the letter **p**? a. 110^o b. 90^o c. 70^o d. 100^o
12. What is the value of the letter **q**? a. 110^o b. 90^o c. 70^o d. 100^o
13. Calculate the value of the letter **r**? a. 110^o b. 90^o c. 70^o d. 100^o
14. What is the value of the letter **x**? a. 110^o b. 90^o c. 70^o d. 100^o
15. Find the value of the letter **y**? a. 110^o b. 90^o c. 70^o d. 100^o
16. Calculate the value of the letter **z**? a. 110^o b. 90^o c. 70^o d. 100^o

Use figure 6 to answer questions 17 to 20. The lines AB and CD are parallel lines

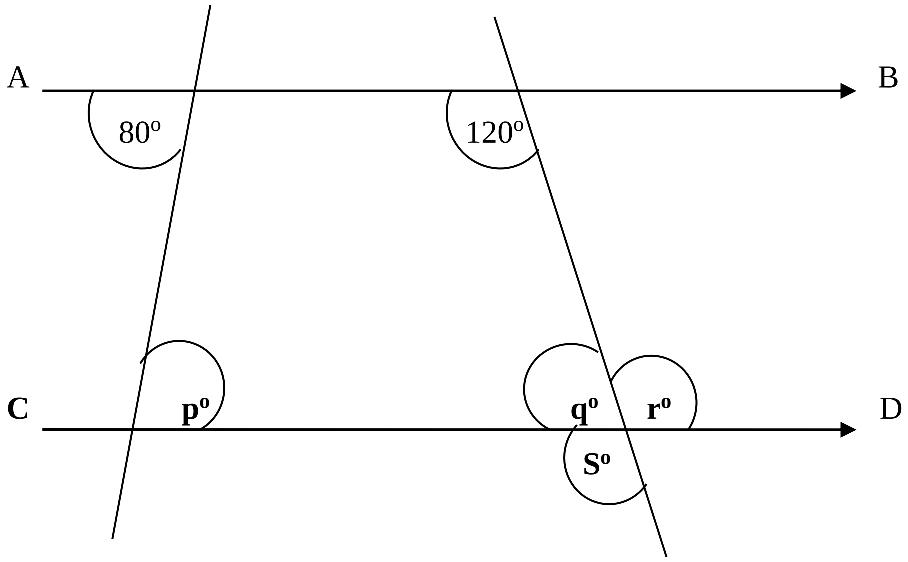


Figure 6:

17. What is the value of the letter **p** in figure 6?

a. 80° b. 60° c. 120° d. 100°

18. Calculate the value of the letter **q** in figure 6?

a. 80° b. 60° c. 100° d. 120°

19. Find the value of the letter **r** in figure 6?

a. 80° b. 60° c. 120° d. 100°

20. What is the value of the letter **s** in figure 6?

a. 80° b. 60° c. 100° d. 120°

Find the values of X in figures 7 to 9.

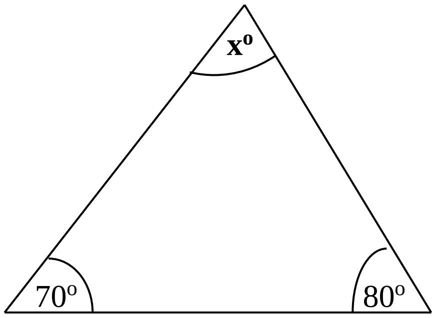


Figure 7:

21. Find the value of X in the figure 7.

a. 60º
b. 50º
c. 40º
d. 30º

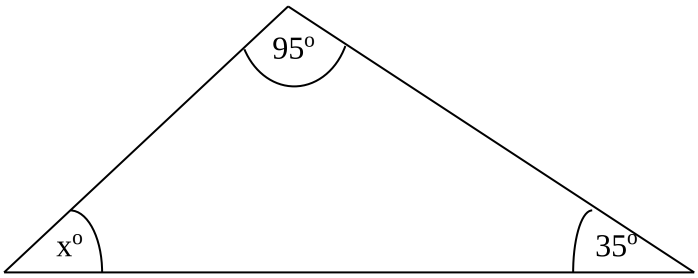


Figure 8:

22. What is the value of X in figure 8?

a. 40º
b. 60º
c. 50º
d. 45º

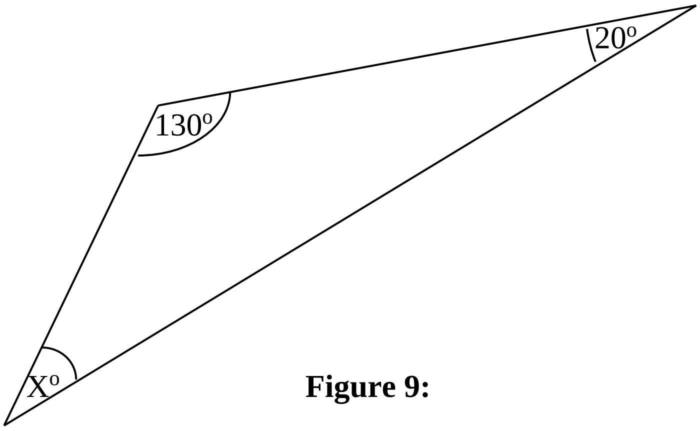


Figure 9:

23. Calculate the value of X in figure 9?

a. 30º

b. 50º

c. 40º

d. 20º

Calculate the values of Y in figures 10 to 11.

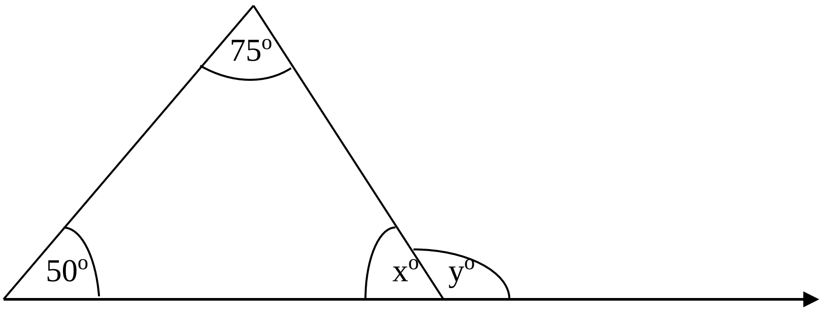


Figure 10:

24. What is the value of Yin figure 10?

a. 55º

b. 85º

c. 120º

d. 125º

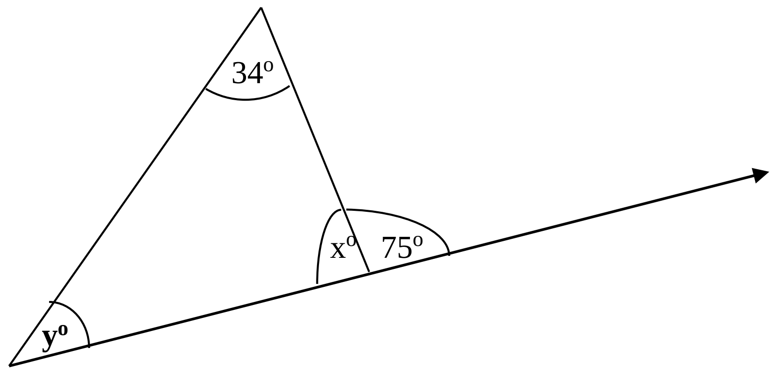


Figure 11:

25. Calculate the value of Y in figure 11.
    a. 41^o
    b. 39^o
    c. 37^o
    d. 51^o
26. Two angles which add up to 180^o are known as supplementary.
    a. True
    b. False

27. An angle greater than 180^o but less than 270^o is obtuse.
    a. True
    b. False

28. An angle greater than 180^o but less than 360^o is reflex.
    a. True
    b. False

29. Two angles with a common vertex and common sides are adjacent angles.
    a. True
    b. False
30. The sum of the interior opposite angles of a triangle is equal to the exterior angle of a triangle when one side of the triangle is extended.

a. True
b. False

APPENDIX E

A Tutorial on SHS 1 Plane Geometry Syllabus